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SUITABLE METHODS OF ILLUMINATION.

Much has been said of late about the proper methods of illumination and the ways in which we should endeavor to obtain it. We have, it is true, allowed this art to lag sadly behind others—in fact, it has been almost entirely neglected. Those who have given some thought to the matter have worked rather in the dark and not approached it in a scientific way. Now the subject is receiving a good share of attention. It is being attacked from all sides, and we are learning from experiment the effects of different sources of light, how they should be treated for the best result, and how any desired result may be obtained. A clear exposition of our present knowledge was made at the meeting of the New York section of the Illuminating Engineering Society by Dr. Charles P. Steinmetz, who for an hour and a half kept the interest of his audience during a discussion of the physical and physiological phenomena connected with light and the proper methods to be followed to obtain any desired character of illumination. Dr. Steinmetz's wide knowledge, which seems to include something from every branch of science and something about every art, enables him to throw upon these matters an exceptionally clear light and to bring to the subject a great deal of interest.

One of the most interesting points made in this lecture was that calling attention to the differences brought about by the different methods of illumination. As a general thing, illumination should be more or less uniform, sharp contrasts being avoided. Uniformity may be obtained by diffused light or by directed light. The former case is marked by the absence of shadows, and the latter by sharp shadows. Neither method is alone entirely satisfactory, the best results being obtained only when they are combined. This is because the eye, while it is dazzled by sharp contrasts, sees by comparison and there should be provided the necessary gradations, which enable it to distinguish objects.

The eye further sees also by colors, so that the necessity of shades is not so great where the color effects are more marked. These are truths which have only recently been recognized.

Another phase of the illumination problem is that of adapting the various characters of light which we now have to the conditions which they suit best, or, rather, to apply in every particular case that type of illuminant which is most effective. For example, in a shop the light should be yellow, because green is not reflected from dark walls. In the parks the reverse is true, because here the reflecting surfaces are green. Further, for inspection work a light may be selected which makes defects more apparent, and a green light is generally better for this.

We now have illuminants giving us a wide range of character,

both as to color and intrinsic brilliancy. The art of producing light, while in some ways backward in that it is hampered by an inefficient method, still is well advanced in other ways—in fact, it is much more advanced than is the art of illumination. It remains for the illuminating engineer to make the most of the various lamps now at his disposal. The efficiency of the lamps will undoubtedly be improved from time to time; in fact, the last year has been productive of a great step forward. But, for the present, this is really a secondary matter as compared with the proper use of the lamps we have.

CONDUCTIVITY AND MAGNETISM.

One of the most puzzling studies in physics has been that of conductivity of materials, both for electricity and heat. Heat is supposed to be the vibratory motion of the molecules of a substance; but electricity is something different. According to the old ideas of electricity the various phenomena met in the study of electrical conduction were puzzling, to say the least. The resistance of a metal increases with temperature, that of electrolytes as a rule decreases, while that of some solid bodies, such as carbon, decreases. Then there is the effect of magnetic field in decreasing—in some cases increasing—the electrical conductivity. That this problem is in some way closely allied to the conductivity of heat was pretty well recognized, but we had no way of picturing to ourselves just what was going on.

The electron theory, fortunately for those who advocate it, meets many of these difficulties, and offers an explanation which can be understood. According to this theory, electrical conductivity is brought about by the actual flow or movement of electrons along the conductor in a direction opposed to our positive current. Every molecule has associated with it one or more of these electrons, but, just as is assumed in the electrolytic theory of dissociation, only a few of these electrons will at any moment be dissociated from their atom, and, therefore, free to move. This being the case, the more widely separated the molecules—as, for example, by heat—the less will any particular electron be under the influence of neighboring molecules, and the more firmly will it be held by its own. Therefore, under such conditions, there will be fewer electrons free at any moment to take part in conduction, and the resistance to flow should be greater, as we know it is.

Further, if the flow of electricity be due to these little negative particles, their motion will be affected by a magnetic field, as was discovered by Hall. If a current be passed through a thin sheet of metal placed in a strong magnetic field the sides of this metal, which are at the same potential when the field is absent, show a difference of potential as soon as it be set up. Further, this deflection of the electron stream, interfering with it as it does, should increase the electrical resistance, as it does.

An effect similar to the Hall effect, just mentioned, is found when studying a flow of heat, a difference of temperature appearing under the effect of a magnetic field where before there was none. This is also explained according to the electron theory by the fact that if heat is due to the motion of molecules, and is transferred from one to the other, there is no reason why the electrons themselves should not take part in this action. Any force, then, which interferes with the flow of electrons must, to some extent, interfere with the flow of heat, and this has been found to be the case. Moreover, these two effects are intimately connected, for when a difference of potential is found, due to the magnetic field, there is also a difference in temperature, and, *vice versa,* a difference in temperature is accompanied by a difference in potential. These are ideas suggested by the electron theory as proposed by Lorentz, but as yet there is only a little experimental evidence dealing with the subject, which is a rather difficult one to investigate. From time to time, however, some light is thrown on the matter, and fortunately for the electron theory this is generally in accord with it or can be viewed so as not to appear at variance. In the *Physikalische Zeitschrift* for November 1, two notes appeared, dealing with different phases of this subject. L. Grunmach, in a study of electrical resistance in magnetic fields, presents results dealing with a large number of metals. The values in most cases are comparatively small, the effect produced by a magnetic field of 16,000 centimetre-gramme-second units being only a fraction of a per cent. Bismuth is an exception, but the behavior of bismuth in magnetic fields has been known for some time simply for this reason, the resistance changes being very much greater than those of other metals. An interesting feature of Grunmach's investigation is that which shows the behavior of the ferro-magnetic metals.

The other note deals with the ratio of thermal and electric conductivities. According to the electron theory, as has been pointed out, the ratio of the thermal to electric conductivity of a material is significant. M. Reinganum has investigated this ratio for various metals, and finds that when plotted as ordinates on a base representing atomic weights that the elements may be divided into two classes, the paramagnetic metals lying above a line, the diamagnetic below. Bismuth, however, is an exception, but this is explained by assuming that the exceptionally great volume of the bismuth atom reduces the electrical conductivity.

It might be mentioned that paramagnetism is explained by assuming that the electrons associated with paramagnetic metals have comparatively large orbits, which enable them to be oriented by an external magnetic force.

THE PHYSICAL MEANING OF POWER-FACTOR.

The student of electrical engineering has a powerful tool put in his hands in the mathematical process of dealing with harmonic motion. All alternating-current theory is based upon the idea of simple harmonic forces. It is true that it is well recognized in practice that this condition seldom prevails; but it is, in many cases, very closely approximated to, and in all cases the results obtained by this method of treatment may be modified so as to give values which are accurate enough for all purposes. To-day we know a great deal more about the modifying reactions and forces which are encountered in our electrical supply

systems and devices, and have thus been able to extend the mathematical theory so as to allow for them.

Another great advantage to the student is the use of graphics—diagrams representing the relations of the various forces and quantities under consideration. These present to him a picture of a foundation, upon which he can build up his ideas and from which he can deduce results. These two methods of graphical analysis and the algebra of harmonic motion are essential to all students desiring more than a superficial knowledge of alternating currents.

It is the general practice, therefore, to introduce the student to the subject through these two methods—in fact, in no other way can he so clearly arrive at an understanding of the subject. But the instructor should always point out the limitations of the methods, and he should show that as soon as the phenomenon departs from a simple harmonic motion the methods must be modified accordingly, or the results which they give should be interpreted with the modifications in mind; otherwise discrepancies and misleading conclusions are apt to be drawn.

An example of this kind is sometimes met in determining the power-factor. In the simple mathematical treatment the power-factor is defined as the cosine of the angle of the phase difference between electromotive force and current. It is shown that by multiplying together the effective values for current and electromotive force and introducing the cosine of the angle of phase difference as a factor that the true power is obtained. In the graphical treatment this definition results directly from the method. The power is, of course, the product of either one of the vectors by the projection of the other one upon it, and this projection is equal to the projected line multiplied by the cosine of the angle.

If, now, the curves be not sinusoids, a difficulty in determining the power-factor in this way will be met. It may be found that although the two curves cross the axis at the same point that the power, as measured by a wattmeter, will be less than that given by the product of the effective values—that is to say, although there is no phase displacement the power-factor is less than unity. Some have sought to avoid this inconsistency by considering this phase displacement as that separating the maximum points of the two curves, but here again the same trouble may be encountered; and, moreover, one curve may present two or more maxima. The trouble is simply one of definition, and disappears if a proper one be made. If, in the first place, the power-factor be defined as the ratio of the true to the apparent watts, there is no difficulty. Then it may be shown that with simple harmonic curves this ratio is always equal to the cosine of the angle of phase displacement. Moreover, when defined in this way power-factor has a physical meaning, while if one adhere to the mathematical definition one is frequently in a quandary. What, for example, is the power-factor of an unbalanced polyphase system? Taken as a ratio of true to apparent watts, there is no uncertainty.

This subject—the physical meaning of power-factor—is very interestingly discussed in the *Journal of the Franklin Institute* for December by Professor Albert F. Ganz, who shows peculiar wave forms obtained from various electrical devices now in use, which illustrate very nicely the necessity for a clear understanding of the physical meaning of power-factor.

THE VICTORIA FALLS POWER SCHEME.

The various phases of the proposed development of Victoria Falls, on the Zambesi river, South Africa, have been followed with much interest by the engineering world. At first there was a feeling of awe at the stupendous undertaking, but this gradually disappeared as more definite information rapidly decreased the available horse-power of the falls. The problem is nevertheless one of great magnitude, because the power which it is sought to develop there is not disposable in the neighborhood, but must be carried some 700 miles to be sold. Various have been the schemes discussed in connection with this, one being the series direct-current system, used to a limited extent in Europe. More recently the statement made in the European press, that the development which would first be sought would be one of only 30,000 horse-power, has brought the problem down to rather ordinary dimensions, except, of course, with respect to the length of the transmission line.

The most recent information dealing with this scheme was given out a short time ago in London. The plans proposed are merely tentative, and may, and probably will, be greatly modified before being put into execution. The company owning the concession purposes first to build a steam power-plant at the Rand. The output of this is to be built up until about 20,000 horse-power is being sold; then the company will be ready to go ahead with the hydraulic development. The plans for the latter contemplate a 30,000-horse-power hydraulic station near the falls, although, by digging a moderate canal, this could be doubled, because of the rapid fall of the Zambesi river. From the power-house power is to be transmitted at 150,000 volts, three-phase, on wires placed at the corners of fourteen-foot equilateral triangles. The distance between the wires, it is hoped, will reduce the loss between them, and to reduce this still further, aluminum conductors are to be used, possibly of such design as to increase their external diameter.

With such an expensive transmission system a method of improving the load-factor at the delivery end must be considered. That now proposed is to load motors at the receiving station with pumps, regulating the pumps to maintain the load constant. These pumps are to raise water from a low-level reservoir to one 600 feet above it. During periods of heavy load this water will be allowed to flow back and thus tide over the station.

The plans as proposed are rather indefinite for criticism, though to jump from something over 50,000 to 150,000 volts is a pretty big stride. The hydraulic storage battery is also a novel feature which must be very carefully studied before reliance is placed upon it. But to jump from 200 to 700 miles is also a big step which will doubtless necessitate some departures in engineering, which at first sight appear startling.

ROTARY CONVERTERS VERSUS MOTOR-GENERATORS.[1]

BY MILES WALKER.

The use of apparatus for converting from alternating into direct current is increasing every day. At present over sixty per cent of all the alternating current power generated is transformed into direct current before it is used. The present tendency in the design of power distribution systems is to make the power stations of very large capacity, and distribute over wide areas. This necessitates the generation of alternating current power, so that in the future we may expect the bulk of our direct-current supply to be obtained from converting machinery.

In order to compare the advantages of the rotary converter over the motor-generator for the various classes of work it is necessary to take into account a great number of features, and for this purpose I have made out a table in which the advantages and disadvantages are set out in columns.

The four types of apparatus which are in commercial use at the present time are the rotary converter, the motor-converter, the synchronous motor-generator, and the asynchronous motor-generator. I have included in the table the permutator, the electrolytic rectifier, and the mercury vapor rectifier—not because they are at present serious competitors, but because they may at some future time become competitors. We may, however, mainly confine our attention to the first four.

Beginning with the question of starting, the usual practice with large rotary converters is to employ starting motors, because experience has shown that this method of starting is exceedingly simple and satisfactory. Where, however, there is any objection to its use, it is possible to start up either on the direct-current side or on the alternating-current side. For low-frequency rotaries, starting up on the alternating-current side without starting motors and without synchronizers can be recommended. Where it is necessary to cut down the starting current to the lowest possible minimum, ball bearings may be used with safety up to the 500-kilowatt size. Ball bearings have been installed at Leeds, England, on 325-kilowatt rotaries, and have proved satisfactory. One of these rotaries will easily start on one-fifth of the voltage of supply, and the maximum current on starting up does not exceed one-third of full-load current on the high-tension side. For larger sizes, if it were necessary for any special reason to start up on the alternating-current side, special provision can be made in the design of the rotary to limit the starting current to a very small amount. One reason which has been brought against the use of rotary converters in traction work is that, if, owing to failure in the generating station, there is a general shutdown, it is much more difficult to start up again than it is to start up with induction motor-generators which can be started without synchronizing. This objection can be met by using self-starting rotary converters, such as are installed at Leeds and at other places. A self-starting rotary may have attached to it a small exciter in order that its polarity may with certainty be brought up the right way in the first instance. In starting up after a general shutdown with a rotary of this type, all that is necessary is to see that it is disconnected from the direct-current bus-bars, the starting switch is then closed, and the rotary comes into synchronism in about half a minute. After the voltage is adjusted to the right figure, it can be immediately thrown on the direct-current bus-bars. This is in all respects as simple as the starting up of an induction motor-generator set. The position of the motor-converter in the matter of synchronizing is the same as the rotary. There is supplied with the motor-converter a little instrument which indicates when the current in the rotor is at the minimum; after the starting switch has been closed, the current in the rotor rises and falls, depending on the change of frequency. It is just as difficult to hit off the right time for throwing in the motor-converter by observing this instrument as it is to hit off the right time for throwing in a rotary converter by means of a synchroscope, and the time taken is the same under the same conditions, and depends somewhat on the skill of the operator.

The synchronous motor-generator of course can be started either by means of a starting motor or on the direct-current side, or can be made self-starting on the

	Starting.	Synchronized.	Parallel Operation. A. C. Side.	Parallel Operation. D. C. Side.	D. C. Voltage. Variation with A. C.	D. C. Voltage. Variation with Frequency.	D. C. Voltage. Hand Adjustment.	Compounding.	Commutation.	Overload Capacity.	Risk of Breakdown on H. T. Side.	Power-Factor.	Efficiency with Transformers 1,000 K. W.	Attention.	Floor Space.	Cost.
Rotary converter	Starting motor. Start D. C. side. Self-starting	Yes. Automatic	Good	Good	Yes. Automatic regulator	No	Yes	Yes	Excellent	Very great	Small	Unity	91½%	1	1	....
Motor converter (Peebles-la Cour)	Self	Yes	Good	Good	Yes	No	Yes	Yes	Good	Fair	Greater	Variable	92½%	....	1¾	....
Synchronous motor-generator	Starting motor. Start D. C. Side. Self-starting	Yes	Fair	Good	No	Yes. Bad	Yes	Yes	Fair	Fair	Greater	Unity	90%	2	2¼	....
Asynchronous motor-generator	Self	No	....	Good	No	Yes. Bad	Yes	Yes	Fair	Fair	Greater	Variable	89%	1	2¼	....
Permutator	Starting motor	Yes	....	....	Yes	No	....	....	?	....	Small	....	95%	....	½	....
Electrolytic rectifier	....	No	....	....	Yes	No	....	....	....	....	Small	....	....	....	....	....
Vacuum rectifier	....	No	....	....	Yes	No	....	....	....	....	....	....	High ?	....	....	....

[1] From a paper read before the Manchester section of the Institution of Electrical Engineers of Great Britain, December 4.

alternating-current side when suitably designed.

In this connection it should be pointed out that when suitable switching arrangements are made, it is just as safe and as easy to start up a rotary on the direct-current side as it is to start up a motor-generator in this way. The objection which has been raised to starting up a rotary on the direct-current side is that in adjusting the speed for the purpose of synchronizing with the alternating-current side, the field current has to be altered, and it does not necessarily follow that at the time of synchronism the alternating-current voltage of the rotary is equal to the alternating-current voltage on the bus-bars. If the alternating-current switches are closed under these conditions, a very large current might flow from the alternating to the direct-current side or the reverse. The following arrangements, however, have been made to meet this difficulty, and are successfully employed on large rotaries in New York. The alternating-current switches are electrically controlled. By a small addition to the direct-current circuit-breakers, the current which operates the alternating-current oil switches is made to pass through a tripping coil which trips the direct-current circuit-breaker a fraction of a second before the alternating-current circuit-breaker is closed. With this arrangement a rotary converter can be run up as a direct-current motor, its speed adjusted until the rotary is in step with the high-tension bus-bars, the electric control switch for the oil switch is then operated, and the rotary taken off the direct-current bus-bars a fraction of a second before it is placed on the alternating-current bus-bars.

The induction motor-generator, of course, does not require synchronizing at all.

PARALLEL RUNNING.

We now come to the question of parallel running. There is a prevalent opinion that a fifty-cycle rotary converter hunts; this is true of a badly designed rotary converter, but is not true of a properly designed machine when working under reasonable conditions, such as can ordinarily be found in the substations of towns. I have seen a 250-kilowatt, fifty-cycle rotary running in the Polygon substation, Manchester (where the variation of frequency and voltage are admittedly very considerable) in parallel with motor-generator sets in a highly satisfactory manner; there was not the slightest suspicion of hunting. The rotary took its load with the motor-generators, and was in every way perfectly stable. The parallel operation of a fifty-cycle rotary converter when properly designed is in every respect satisfactory, and the statement to the contrary is based only on experience with antiquated machines. The parallel running on the alternating-current side of a rotary converter is really considerably better than the parallel running of a synchronous motor-generator set, because the rotating part being lighter, the speed can be more easily changed to meet the sudden changes of frequency. In case of a heavy load, the rotary has an enormous advantage, because the heavy load makes very little difference to the mechanical turning moment called for, whereas with a motor-generator, the turning moment is proportional to the load. In the case of a rotary, the work is done by the transformers. It is hardly felt by the running machine, which merely acts as a conductor. The disadvantage of the synchronous motor-generator in this respect is to a certain extent shared by the Peebles-Lacour motor-converter. It is not true that the motor-converter has a greater synchronizing power than the rotary. The synchronizing current taken by a rotary is only limited by the resistance of the line and the small resistance and self induction of its armature, whereas the synchronizing current of a motor-converter is limited by the self induction both of the stator and rotor of the induction motor end. With regard to the parallel running on the direct-current side, all types stand on the same footing.

There are really four different questions to consider in connection with the variation of voltage. There is the question how far the direct-current voltage varies with the alternating-current voltage; there is the question how far the direct-current voltage varies when the frequency varies; also how far it is possible to obtain hand adjustment of the voltage through any required range; and there is the further question of automatic compounding when load comes on.

As to the variation of the direct-current voltage with the alternating-current voltage the table shows exactly what the position is. The direct-current voltage and the alternating-current voltage of both the rotary converter and the motor converter vary together. The simple motor-generator has an advantage in this respect in that the direct-current generator is entirely independent, and so long as it is running at constant speed and load gives a constant voltage. In cases where the alternating-current voltage is unsteady and it is required to preserve a constant direct-current voltage, the motor-generator will be the simplest apparatus to employ, but the superior efficiency of the rotary converter will sometimes make it worth while to introduce automatic voltage regulators, so that a steady direct-current voltage can be maintained, notwithstanding variations in the alternating-current supply. Automatic regulators have been designed which will hold the direct-current voltage constant within half of one per cent, notwithstanding the variation of the alternating-current voltage through a range of ten per cent. When we consider how the direct-current voltage varies with the frequency, we see that the positions of the rotary and the motor-generator are reversed. The direct-current voltage of a rotary is not dependent upon the frequency, whereas with the motor-generator a change in the frequency of one per cent will often make a change in the direct-current voltage of two per cent.

It is possible to carry out hand adjustment of voltage through wide ranges on all four classes of apparatus. In the case of a rotary converter there are four methods by which the adjustment of voltage can be obtained.

The simplest method is to build the transformers feeding the rotary with a high inductive drop. The rotary then behaves very much as a shunt-generator. By increasing the excitation we increase the voltage; by decreasing the excitation we decrease the voltage. The only drawback to this method is that the power-factor varies as the voltage is varied. As it generally happens that it is at heavy loads that we require to raise the voltage, a leading current is rather a good point, as it helps out the lagging current taken by any induction motors on the system, and tends to raise the voltage of the generators. Moreover, anywhere in the neighborhood of normal voltage the power-factor is near unity. It is only when we reduce the voltage below normal that the power-factor comes over to the lagging side.

The second method for obtaining hand adjustment of the voltage is to put an alternating-current booster on to the shaft of the rotary, and change the alternating-current voltage supply of the rotary by varying the field of this booster. In the rotary converters recently supplied by the British Westinghouse Company to Bristol, Bradford and Moscow, this method has proved in every way satisfactory. For instance, at Bristol the rotaries are designed for either lighting from 460 volts to 500 volts, or for traction with automatic compounding from 500 to 570 volts.

In addition, this booster enables us to

preserve complete control over the power factor, notwithstanding any change in the voltage. In all cases where a very wide range of voltage, say up to twenty-five per cent, is required, the booster method is to be preferred to the self-induction method. We may take ten per cent range in voltage as being the practical limit in this latter case, though by special arrangements it can be extended to fifteen per cent.

The third method is by connecting an induction regulator between the transformers and the rotary. One of the objections to the use of these regulators is that they require cooling by an air blast; this, however, is not a serious objection where air-blast transformers are used. In cases where an air blast is available, the induction regulator is to be preferred to the alternating-current booster, if the number of poles on the rotary is very great. It will be understood that the number of poles on the booster must be the same as on the rotary. Where the number of poles is as great as thirty the induction regulator, in which the number of poles can be made as few as we like, makes a cheaper and more compact machine.

The fourth method of adjusting the direct-current voltage is to bring taps from the transformers either on the high-tension side or on the low-tension side, and change the working tappings by means of a dial. It used to be said that this method was only advisable up to the 250-kilowatt size of rotary converter, but the Westinghouse Company has recently improved its methods of making dials dealing with large currents at high voltages, so that it is difficult to say what the limit in size now is. There will, of course, always be an objection to any system in which tappings from the transformer are brought to a dial, on account of the possibility of accidental short circuits. This method, therefore, should not be put forward unless there were special circumstances which make it advisable.

All four classes of converting apparatus are the same in the matter of automatic compounding. It is just as easy to obtain a compounding effect of ten per cent between no load and full load on a rotary converter as it is on a motor-generator. This compounding can either be carried out by putting a series coil on the field of the rotary and self-induction in the transformers feeding it, or by adding a series coil to the alternating-current booster fixed on the shaft.

There are some cases where a reversed compound winding is useful; for instance, where it is intended to run rotary converters in parallel with shunt-generators, the transformers should be designed with considerable self-induction, and a reversed series winding put on the rotary converter. This gives the rotary all the characteristics of a shunt machine. When the load comes on, the voltage falls, and by arranging a suitable German silver shunt, the characteristics of the machine may be made to imitate very closely the shunt-generators with which it is to run in parallel.

On all direct-current machines good commutation is a most important feature. It is common knowledge that the problem of commutation on a rotary converter is very much easier than on direct-current machines, as there is very little field distortion by the armature current, so that excellent commutation can be obtained through very wide ranges of load. Even up to three and four times full load, current can be collected from a rotary converter without excessive sparking or flashing over, and up to 100 per cent overload can be commutated sparklessly. The great overload capacity of the rotary converter is due not only to its good commutating qualities, but to the fact that the copper losses in the armature are small on overloads.

The consideration which is most important to a station engineer is freedom from breakdown. For smallness of risk of breakdown, the rotary converter and its transformers is superior to any other converting machinery, because in the first place there is no high voltage on the running machine, and in the second place there is only one running machine to break down, instead of two. A well-insulated transformer is very much less liable to break down than any kind of high-voltage armature. Even if one of the transformers does break down the load can be carried on the other two.

As is well known, the power-factor of a load of rotary converters can be adjusted to any desired figure by varying the excitation. In ordinary traction work, where the rotaries are compounded, the power-factor varies with the load and it is usually arranged that on full load there is a leading power-factor on the high-tension side between ninety-nine per cent and ninety-six per cent. This gives a slight leading component which of course is desirable on full load.

The rotary converter and motor converter are much the same in the matter of adjustment of power-factor, the main difficulty being that the induction part of the motor-converter always has a high self-induction, and therefore with changing load and changing frequency the power-factor will always be beyond the control of the operator, whereas with a rotary converter, where it is important to preserve unity power-factor at all loads, the self-induction in the transformers can be made extremely small, and an alternating-current booster can be added in those cases where variation of voltage is required, so that the power-factor is always completely under control without regard to the particular voltage at which it is required to run.

The synchronous motor-generator set is the same as the rotary converter in this respect, that the power-factor is completely under control in all circumstances.

The asynchronous motor-generator set has a lagging power-factor less than unity.

The rotary converter has a substantial advantage in respect to efficiency over any other type of converting apparatus. It is not true that the motor-converter has all the advantages of a motor-generator, and as high an efficiency as the rotary. In comparing the efficiencies of different machines it is very important to consider the basis of their ratings. When a substation is supplying a town load it is always necessary to have enough machines running to avoid catastrophe in the case of sudden unexpected demands. The efficiency of the substation will greatly depend upon how many machines are running, and how near to full load they are working. If the station is provided with rotary converters, it is in most cases perfectly safe to have all the rotary converters fully loaded and allow them to be overloaded before a new machine is thrown in. This is because the rotary converters can take fifty per cent overload for an hour or two in case the load should be unexpectedly increased. Moreover, they can take 100 per cent overload without any commutation troubles for a time sufficient to synchronize and throw in additional machines. When dealing with motor-converters or motor-generators, which are not able to take such excessive overloads without danger, the station engineer is not justified in normally running his machines up to such a high point. He must, except for the very steadiest loads, always have some capacity in hand to meet sudden demands and give him time to throw in other machines. In making a fair comparison of the year-round efficiency of different types of converters it would not be unfair to take the efficiency of the rotary at full load and the other types of apparatus at three-quarter load. In the table, however, I give efficiencies without regard to this additional advantage on the

part of the rotary. I compare machines designed with the same liberality and same factor of safety in insulation and mechanical strength.

In the amount of attention required to keep a machine clean and in good running condition the rotary converter is just twice as good as its competitors. There is only one machine to keep clean instead of two, and, moreover, the easy commutation enables the carbon brushes to run for years with only the slightest wear.

In the matter of floor space the rotary is again at the head, provided the transformers can be placed in a lower or upper story, as is often the case.

In the same factory, with the same class of materials, theoretical considerations show that the rotary converter and transformers should be cheapest to build. The actual market price is governed by a large number of considerations which are out of the sphere of this paper.

Annual Meeting of the Electrical Committee of the Underwriters' National Electric Association.

The annual meeting of the Electrical Committee of the Underwriters' National Electric Association will be held in March, 1907, in New York city. The day and place of the meeting will be announced later.

As usual, the provisions of the National Electrical Code as they now exist will be the principal matter for consideration, and it is requested that any desired change in, or addition to, the Code, be forwarded to C. M. Goddard, 55 Kilby street, Boston, Mass., on or before February 1, 1907, in order that it may be printed in the bulletin, and the committee and other interested parties may thus have opportunity to consider same in advance of the meeting.

Final action on suggestions not received in season for consideration by the committee before the meeting can only be taken by unanimous consent.

As heretofore, the meeting will be open to all interested, and such persons will not only be welcome, but are urged to be present and give the committee the advantage of their experience and advice.

According to the *Bulletin* for December, the net gain for the New York Edison Company, for the year ended October 31, was 924,875 equivalents. For 10,709 new users, these figures were made up of 448,654 incandescent lamps; 6,774 arc lamps; 29,592 horse-power in motors, and some additional apparatus and appliances of a miscellaneous order.

BOOK REVIEWS.

"Turning and Boring Tapers." Second edition. Fred H. Colvin. New York. The Derry-Collard Company. Paper. 26 pages. 5½ by 8 inches. Illustrated. Supplied by the ELECTRICAL REVIEW at 25 cents.

This little pamphlet is the second edition of No. 1 of a series of practical papers put out by the publisher. It deals with methods of turning and boring tapers on various machines.

"The Copper Handbook." Vol. vi. Horace J. Stevens. Houghton, Mich. Published by the author. Cloth. 1,116 + 66 pages. 6½ by 9 inches. Supplied by the ELECTRICAL REVIEW: cloth, with gilt top, $5; full library morocco, full gilt, $7.50.

This is an extremely valuable publication exclusively devoted to the copper industry. The sixth volume is issued several months later than usual owing to the sickness of the author last spring. However, matter of much later date has been used than in the preceding issues, so that the book is as nearly up to date with regard to time as its predecessors have been, and is far more bulky and exhaustive in its treatment of the copper industry. The work begins with a chapter on the history of copper, followed by articles on the geology, chemistry, mineralogy, metallurgy and uses of the metal, with eight chapters devoted to condensed descriptions of the known copper deposits of the globe. There are also a useful glossary of mining terms and complete statistics of the copper trade and copper share finances. The major portion of the book is devoted to a chapter describing all the known copper mines of the world, and listing every copper-mining company of importance. This chapter is arranged alphabetically by titles.

"Continuous-Current Dynamo Design." H. M. Hobart. New York. The Macmillan Company. Cloth. 220 pages. 6 by 9 inches. 106 illustrations. Supplied by the ELECTRICAL REVIEW at $3.

In this book the author has brought together a good deal of material which he has published in various technical journals. It is put forward as an aid to students in the design of electrical machinery. A feature is the presentation of eighteen complete machine designs in tabulated form, and in each chapter sufficient data are given to enable the student to calculate the parts of the design of each of these machines with which that chapter deals. There are in all six chapters to the book. The first discusses the conducting circuit of the continuous-current dynamo. The second deals with the magnetic circuit, showing how to compute the magnetizing winding, the iron losses, and the field dimensions. Chapter iii deals with the armature reaction and the calculation of efficiency. Chapter iv is devoted to the proportioning of dynamo parts, the selection of the proper voltages and the computation of reactance voltages. In chapter v the determination of design coefficients is taken up, and chapter vi shows the application of the reverse poles to continuous-current dynamos. In an appendix the data for all eighteen of the machines are brought together in tabular form. The author's method of design is well known, and his treatment of the subject is clear and concise.

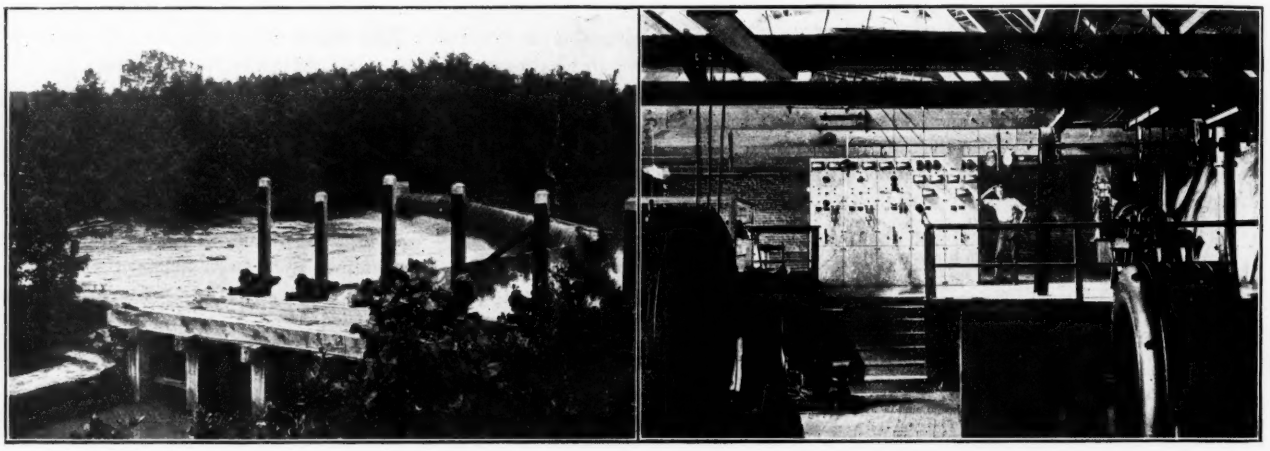
The Use of Electricity in the Mines of Alsace.

In discussing this subject the effect of the German laws governing the use of electricity in mines upon the mining industry in Alsace, attention is called to the important part played by electrical apparatus. In recent years electrical applications have developed to such an extent that hardly any other system is now used, and the reasons attributed for this are the ease of subdividing energy, of transporting it from a distance without considerable loss, the ease with which the motors may be installed, and the absence of smoke and vapors. Two important installations are noticed as pointing out the magnitude of this work. The Société de Sarre-et-Moselle, at Karlingen, operates a generating station with a total output of 2,600 kilowatts, and has installed some fifteen miles of underground lines for distributing power at 5,000 volts. There are in operation five 500-horse-power motors for hoisting, eight 175-horse-power motors for ventilation, a number of transformers, and 118 smaller motors rated at from one to 100 horse-power. The aggregate power of the motors is 2,000 horse-power, and they are utilized for operating all the machinery in the mine. The mines owned by the Rombach Iron Works have also an important installation. The generating station is driven by gas engines using furnace gas. There are three 250-horse-power centrifugal pumps, two 180-horse-power and one ninety-horse-power pumps, all motor-driven. There are four groups of motor-generators of 400 horse-power each, transforming the three-phase, high-tension current to 750 volts direct current for electric haulage. There are for this purpose three 400-horse-power electric locomotives, two 250-horse-power locomotives, and twelve rated at 100 horse-power. The length of the electric railway system is about twenty-seven miles, fifteen of this being under ground.—*L'Électricien (Paris), December* 1.

The Hydroelectric and Steam Equipment of the Athens (Ga.) Electric Railway Company.

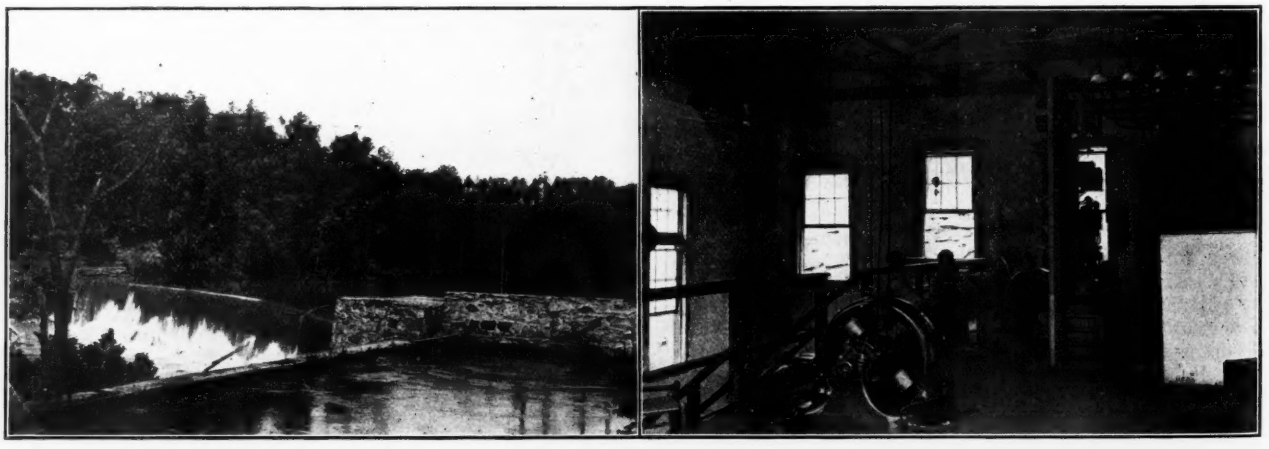
A Story of Modern Electric Railway and Central Station Development.

ORGANIZED in the year 1894, to take over the property of the Athens Railway Company, then in the hands of a receiver, the Athens Electric Railway Company began business in June of that year with five and a quarter miles of track, and a small steam plant containing two seventy-five-horse-power boilers, one 100-horse-power Ball engine, and one eighty-kilowatt Detroit railway generator. Four or five old horse cars equipped with Detroit bevel-geared motors constituted the equipment that had made sporadic efforts to get over the track and convince patrons that if a car was not where it ought to be at a given minute it might reasonably be expected to arrive some time in the future. The organizers of the company not being satisfied with this condition of affairs determined to improve the equipment of the railway and add a lighting department. With this in view they acquired a water power three miles from the city at Mitchell's Bridge, on the Middle Oconee river, the development of which was completed in 1896. The plans called for the erection of a timber dam 400 feet long, averaging twelve feet in height, the mud sill, of twelve inches by fourteen inches heart pine, double-sheet piled, and securely pinned to the rock, the bents of eight inches by ten inches set three feet six inches on centres covered with two-inch rough planks. The face of the dam was laid up with rubble, pointed on the down-river side and the space back of this wall and under the flooring filled with loose rock. Rock abutments of solid masonry anchored the ends of the structure, with head-gates of heart pine to control the flow into the short canal, 200 feet long, leading to the power-house. Below the power-house a natural tail-race, formed by an island in the river, and a crib dam at the power-house end, was blasted out to get additional depth, the difference in the levels of head and tail-water being twenty-one feet.



ATHENS (GA.) ELECTRIC RAILWAY COMPANY—DAM AND HEADGATES, AND INTERIOR VIEW, STATION NO. 1.

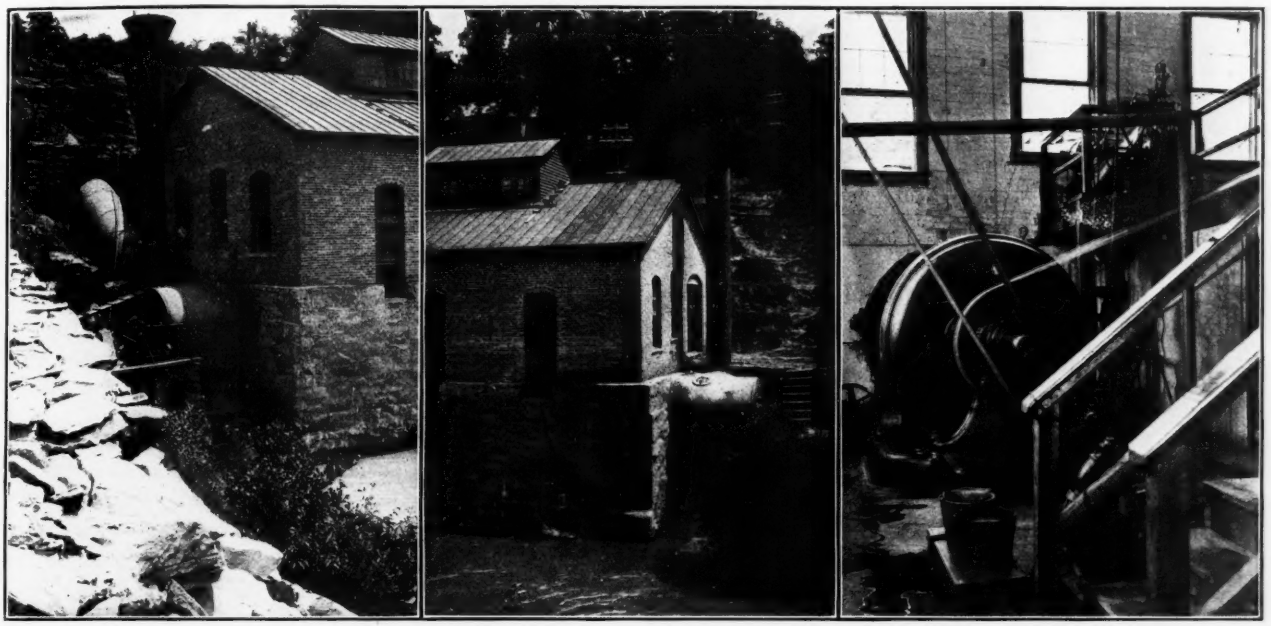
One end of the stone and brick power-house, seventy-five by fifty feet, spans the tail-race, thirty-six feet wide, the wheel-cases resting on twenty-inch I-beams, carrying the centres fifteen feet above tail-water.



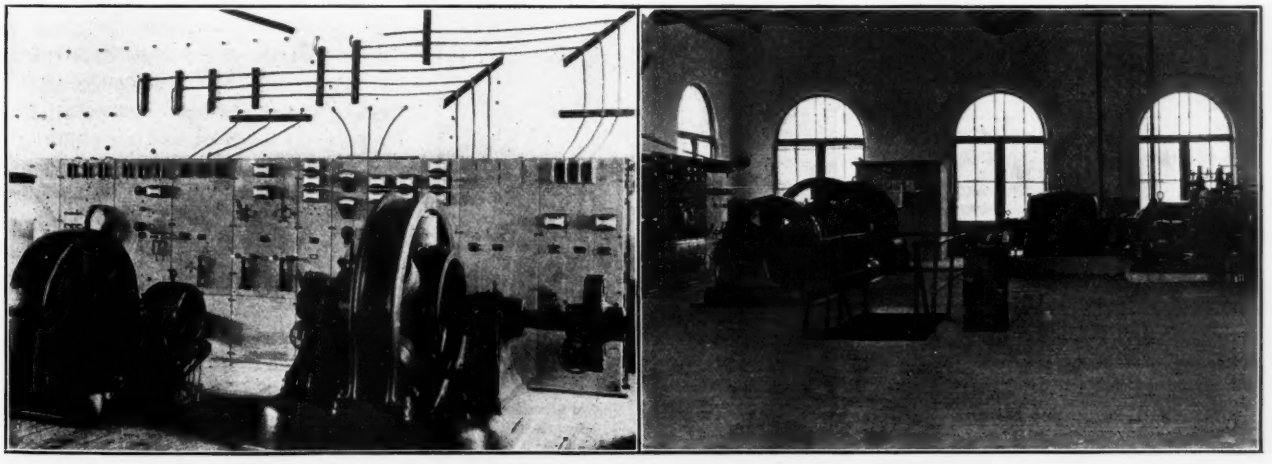
ATHENS (GA.) ELECTRIC RAILWAY COMPANY—DAM AND HEADGATES, AND INTERIOR VIEW, STATION NO. 2.

The generators were installed on brick foundations, the floor level being eight feet above the wheel pit, advantage being taken of the natural trend of the rock to secure a floor level free from dangers from

high water. The hydraulic equipment included one pair of thirty-nine-inch horizontal Victor turbines, one thirty-three-inch horizontal Victor turbine, and a ten-foot flume for an additional wheel. To the large pair of turbines was belted a General Electric monocyclic generator of 250 kilowatts capacity, and to the small wheel the eighty-kilowatt Detroit generator from the original steam station, which later gave way to a General Electric multipolar machine of 150 kilowatts capacity. On the larger turbine an extended shaft provided for a connection to two Thomson-Houston fifty-light arc generators which had been owned and operated by the city authorities with such satisfactory results that the company was able to make a favorable contract to operate these machines, displacing municipal ownership. The water-wheels were controlled by two Geisler governors, which gave fairly good results. In 1900 a single thirty-nine-inch horizontal turbine was installed in the extra flume with a No. 10 Brush arc machine of 100 lights capacity as an addition to the electrical equipment. From each generator a single circuit was carried to the city—4/0 wire for the railway, 1/0 outside wires, and No. 1 teaser wire for the monocyclic, and two circuits of No. 6 for the arcs. With this addition to the generating apparatus which appeared at the time ample for years, the business of the company expanded until in 1900 the continuity of the service was menaced by the heavy load carried by the single equipment for each branch and the directors began to cast about for more power. In 1900 they purchased the Tallassee Shoals property seven miles from the city on the same river a few miles higher up, where a fall of forty-five feet was available. Plans were laid for a complete and radical change in the method of generating and utilizing the power, three-phase apparatus of 2,300 volts replacing the direct-current and monocyclic machines at the old station, and three-phase, 12,000-volt generator specified at the new station. Current from each station is transmitted at the voltages at which it is generated to the substation at the city limits, the 12,000-volt current transformed to 2,300 volts and switched to one set of bus-bars, a second set being provided for the 2,300-volt current from station No. 1. From the switchboard the current is transmitted through lighting and power feeders to the



ATHENS (GA.) ELECTRIC RAILWAY COMPANY—TWO EXTERIOR VIEWS AND VIEW IN GENERATOR PIT, STATION NO. 2.



ATHENS (GA.) ELECTRIC RAILWAY COMPANY—TWO VIEWS IN THE STEAM AND SUBSTATION.

different sections of the city or converted into direct current, for the railway through the medium of a rotary converter and a motor-generator set, the latter made up of the old monocyclic generator with a new three-phase armature and the multipolar generator, both of which had been moved from the No. 1 water power station. Since the completion of this development, the direct-current arc machines have been discarded and alternating-current series-transformers of the General Electric type substituted, furnishing current for 160 lights of 6.6 amperes contracted for by the city.

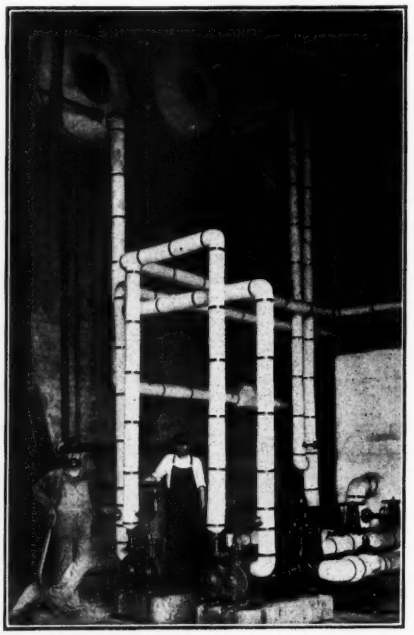
The hydraulic development of the No. 2 station at Tallassee Shoals included the construction of a dam twenty-eight feet high and 360 feet long, the design of which appears novel to some engineers.

Founded upon the rocky bed of the river, the up-river side of the dam is provided with a yellow pine mud sill, twelve inches by fourteen inches, securely pinned to the rock, bedded in concrete, and double-sheet piled on the upper face. Fifty-six feet below this sill on a masonry foundation, twenty feet wide, leveling up the bed of the river, a dry masonry wall was laid and thoroughly pointed on the down-river face which was given a batter of one inch to the foot, while the up-river side of the wall had a batter of one foot in three.

Between this wall and the mud sill loose rock of various sizes and shapes was dumped, with a finished slope from the mud sill to the crest of the dam. Pine rafters were spiked to the mud sill and to a sill anchored in the masonry at the top and upon these a double floor of one-and-one-quarter-inch rough pine was laid. Between the sills to which the planking forming the crest of the dam was spiked concrete was rammed in up to the level of the under side of the flooring. The dam was given a bend up river and the ends anchored with solid masonry abutments, that on the east side being provided with a sand gate and three head gates leading into the canal.

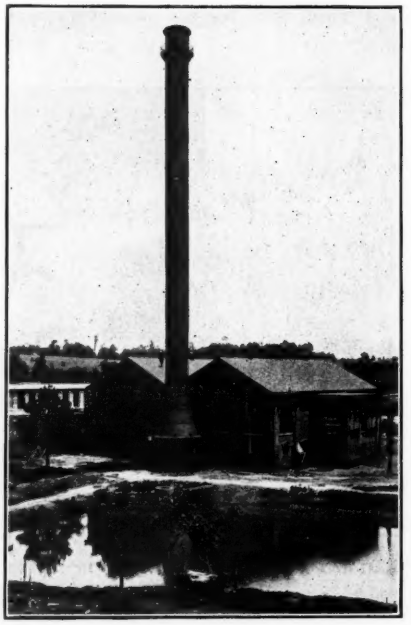
The masonry retaining wall of the first hundred feet of the canal formed a spillway to provide an outlet for any excessive amount of water coming through the gates. From the spillway to the forebay, a distance of 1,200 feet, the retaining wall is of red clay six feet wide at the top with a slope of one and one-half to one on each side.

From the forebay to the turbines the water is conducted through steel flumes six feet in diameter to two pairs of twenty-four-inch Victor horizontal turbines placed fifteen feet above tail-water and set outside the station, the wall of which was built around one head forming a water-tight compartment for the



ATHENS (GA.) ELECTRIC RAILWAY COMPANY—ARRANGEMENT OF STEAM PIPING, STEAM STATION.

generators. The electrical equipment comprised two 450-kilowatt, 12,000-volt, revolving-field generators direct connected



ATHENS (GA.) ELECTRIC RAILWAY COMPANY—STEAM AND SUBSTATION, STACK AND COOLING POND.

to the water-wheel shaft, two twenty-five-kilowatt, General Electric, multipolar exciters belted to the generators; two switchboard panels of blue Vermont marble, equipped with oil switches, watt meters, ammeters, voltmeters, ground detectors, etc., and two Lombard governors, the auxiliary apparatus being placed on a level nine feet above that of the generator pit.

The transmission line, seven miles long, located in as near an air line as possible, consists of six No. 4 B. & S. bare wires in two circuits, transposed three times, on juniper poles set 110 feet apart. Locke insulators (No. 3), carried on paraffined locust pins in heart pine arms, properly braced, formed a triangle of twenty-two inches, one circuit on each side of pole.

Coming into the substation at the city limits, the high-tension wires controlled by oil switches are connected to the primaries of two sets of 150-kilowatt, air-cooled transformers, the secondaries of which are carried to oil switches which throw the current on one or the other of two sets of bus-bars. The feeder panels at all the stations are equipped with Thomson polyphase wattmeters in addition to the standard General Electric equipment of ammeters, voltmeters, power-factor indicators, etc. The lightning protection is of the General Electric type, a varying number of air gaps according to the voltage in series with a graphite resistance with choke-coils between the taps and the switchboards. Provision is also made for the abnormal difference in potential between line and line during seasons of electrical disturbances in the atmosphere.

In addition to its electrical equipment to control and distribute the output of the water power stations as a substation, the steam station, recently completed, is equipped with one Westinghouse 500-kilowatt Parson's turbine connected to a Deane jet condenser and air-pump; one battery of Stirling water-tube boilers of 750 horse-power, equipped with superheat tubes in the middle pass; Cochrane feed-water heater and Deane feed and tank pumps. The brick station building, eighty feet by ninety-six feet, was planned to accommodate four units of the same capacity as now installed. A self-supporting steel stack 150 feet high and 106 inches in diameter provides ample draught for 200 horse-power.

The steam piping, erected under a contract with the General Fire Extinguisher Company, is modern in design, long bends and extra strong pipe being used throughout. All piping is covered with eighty-five per cent magnesia two inches thick, formed in place, wrapped and banded. Water meters, recording steam, vacuum, and temperature gauges and recording voltmeters, are installed in addition to the

integrating wattmeters on the switchboards.

To provide cooling water for the condenser a spring lake four hundred feet long by one hundred and fifty feet wide, protected by storm ditches to divert the muddy water coincident with heavy rainfalls, was constructed close to the powerhouse, the condenser taking water from an intake well at the station end and discharging it through sewer pipe near the head of the pond.

The station is thoroughly modern and up to date, and when filled with the apparatus for which space has been left in the building will be capable of delivering 3,000 horse-power normally or 4,000 horse-power under overload conditions.

The company is pumping the city water, an induction motor of 150 horse-power, direct-connected to a Worthington four-stage turbine pump, forcing one thousand gallons per hour under a pressure of 140 pounds through the city mains.

A thirty-horse-power induction motor, belted to a centrifugal pump, lifts the water from the river to a subsidence reservoir, and a five-horse-power motor operates the filters.

The railway is equipped with two double-truck closed cars, two double-truck open cars, both types equipped with air brakes; six single-truck closed cars, and two single-truck open cars.

The lighting circuits carry 11,933 sixteen-candle-power equivalents, a number of motors under five horse-power, fan motors and heating devices.

The power circuits, four in number, furnish current for 1,190 horse-power in induction motors, operating two cotton mills, one fertilizer factory, one leather factory, one oil mill, two grist mills, two wagon shops, three newspapers, one granite yard and a number of small industries.

The city is lighted with 160 series, alternating enclosed arcs of 6.6 amperes.

The engineering and construction work have been under the supervision of the general manager of the company, C. D. Flanigen, M.E., assisted by W. T. Bryan and H. M. Hughes.

The officers of the company are:

J. Y. Carithers, president.

W. S. Holman, vice-president.

W. T. Bryan, secretary and treasurer.

C. D. Flanigen, general manager.

The board of directors includes these officers and A. H. Hodgson, Billups Phinizy, James White and John R. White.

The company is entirely a home affair, officered and directed by Athens people.

AN ENQUIRY INTO THE OPERATION, EFFICIENCY AND CONSTRUCTION OF A TYPICAL MODERN INDUSTRIAL PRODUCER GAS POWER PLANT.[1]

BY J. R. BIBBINS.

With all the present activity in power development for various purposes, industrial or otherwise, the value of the simple producer plant used exclusively for power generation seems to have been somewhat overlooked, or at least questioned. The ability of the modern gas engine to take the place of the steam engine in general power work has likewise been questioned, as well as the capacity of gas engine and producer to work together harmoniously under widely varying load demands.

Fortunately neither of these charges is founded on a basis of actual conclusive experience, and it is the purpose of this paper to present some practical data upon the operation of a thoroughly representative commercial gas power plant; one in which a high measure of success has been obtained through intelligent engineering and supervision. Even though some minor improvements might still be suggested, the fact remains that this gas power plant is operating week in and week out, twenty-four hours per day six and one-half days per week, on a fluctuating manufacturing load, with a fuel consumption fully one-half that of a modern steam plant of like character and suited to the same work. On an average of half load this 450-kilowatt plant ordinarily consumes from two to two and one-quarter pounds of coal per kilowatt-hour, and, on heavier loads, has reached as low a consumption as one and one-half pounds per kilowatt-hour in regular daily running. During heavy loads the plant has repeatedly developed without the battery 530 kilowatts on maximum fluctuations, which represents an overload of eight per cent rating. Furthermore, with the exception of the engineers in charge during the two watches, the plant is operated by attendants originally quite unskilled in gas work; up to the present writing, however, no complete interruption of service, traceable to defective equipment, has been recorded.

The plant in question serves the entire Gould Manufacturing properties at Depew, a suburb of Buffalo, N. Y. Two complete works are located here; one devoted to the manufacture of storage batteries and the other to the manufacture of railroad specialties, principally automatic couplers. The latter contains a large and well-equipped steel foundry. Both are electrically driven and lighted throughout from the central gas power plant.

Contributing to the station load are a large number of labor-saving machines of different types, such as electric traveling cranes, charging tables, transfer locomotives, elevators, conveyers, fans, pumps and machine shop tools. The storage battery works also use considerable current at times for "forming" battery plates.

TABLE 1—EQUIPMENT DATA.

450-KILOWATT PRODUCER GAS ENGINE POWER PLANT.

Service—Power, some lighting.
Capacity of plant—450 kilowatts.
Number of units—Three, 150 kilowatts.
Distribution system—Direct current, two-wire.
Pressure—250 volts, normal 230.
Power building—Forty-five feet by sixty-one feet inside; height of roof trusses, twenty-eight and one-half feet; height of basement, nine feet; total area per kilowatt, 6.1 square feet; net area of unit, fifteen feet by thirty-three and one-half feet (with six-foot passageways); net area unit per kilowatt, 2.87 square feet.
Walls—Red brick, exterior pilasters, limestone trimmings, steel framework.
Roof—Wood, tar and gravel, steel trusses, monitor.
Floors—Steel, wood, three-quarter-inch maple finish; basement floor, concrete.
Foundation—Concrete.
Crane—Hand-power, tons.
Producer building—Steel framework; corrugated iron walls and roof; charging floor, boiler plate.
Cooling pond—1,000,000 gallons; dimensions, 280 feet diameter by ninety-three feet wide; area (power plant), 7,300 square feet; area (producer plant), 7,500 square feet; total, 14,800 square feet; depth, normal, ten feet.
Holder—Thirty-six inches diameter, single lift, 15,000 cubic feet.
Coal used—Bituminous run of mine.
Sources—Buffalo, Rochester & Pittsburg Railroad.
Price—$2.30 per ton.
Heat value—13,500 British thermal units.
Engines—Westinghouse three-cylinder, vertical gas engines; type, single-acting four-cycle; capacity, 235 brake-horse-power, 260 maximum; normal speed, 200 revolutions per minute; size cylinders (three), nineteen-inch by twenty-two-inch stroke.
Ignition—110 volts and eight volts; two sets four-cells storage battery; one motor-generator set, one-half kilowatt.
Cooling water (jackets)—Motor-driven centrifugal pumps; two two-inch Worthington "Volute"; fifteen-horse-power motor 1,450 revolutions per minute.
Cooling water (scrubber)—Two-stage motor-driven; two-inch Worthington "turbine" type; fifteen-horse-power motor.
Compressed air—100 pounds from works, also six-inch by six-inch Rand duplex single-stage compressor; ten-horse-power motor.
Generators — Westinghouse compound-wound; direct current.
Capacity—150 kilowatts, 250 volts.
Switchboard—250-volt direct-current.
Producers—Loomis-Pettibone; type, bituminous, duplex intermittent blast; three-feet to eight-feet diameter.
Boiler—Five-feet diameter vertical tubular, utilizing waste heat.
Wet scrubber—Six-feet diameter, vertical, coke, water-sprays.
Dry scrubbers—Two nine-and-one-half-feet diameter, in parallel; excelsior, two layers.
Valves—Gear lift, water-cooled.
Exhauster—Roots simple engine-drive.

[1] A paper presented at the New York meeting (December, 1906) of the American Society of Mechanical Engineers. Condensed.

Gas main—Twelve-inch diameter.
Gas risers to engine—Eight inches.
Fittings—Screwed.
Valves—Chapman gate.
Coal handling—Bucket elevator, motor-driven.

Although the power station load is smoothed out to some extent by the overlapping of demands from these various sources, yet the larger machines pull heavily upon the system, with the result that the load at the station bus-bar is subject to violent fluctuations, easily eighty per cent above or below (on light loads 100 per cent) the general averages. As no system of notification is in force, the power station can not be apprised of anticipated demands from the several production departments of the works. The storage battery forming load is, of course, steady while it exists, but it is liable to be abruptly thrown on or off at any time.

A typical run is shown in the accompanying log, Fig. 1, for September 25, 1905. Although the recorded output is fairly steady through the day, the fluctuations correspond on some days to overloads of fifteen to twenty per cent on the engines.

The original plant was entirely capable of handling these fluctuations, but on account of doubling the steel plant load and adding electrically driven air compressors, an auxiliary storage battery[1] was recently installed for the dual purpose of securing a more constant load on the engines, with higher economy of fuel, and of increasing the average load. Formerly it was necessary to keep the spare unit constantly in service to tide over the peaks.

From the daily records of the plant an excellent idea of its operative efficiency may be obtained. These records, although not elaborate, are carefully kept and show not only the output and duty of the plant but also the maximum loads that occur during the hour. During a typical day's run with continuous operation except at noon and midnight—to be exact, ninety-seven per cent of the elapsed time—the load averaged 263 kilowatts, or fifty-eight per cent of the generating capacity in service with nine full load hourly maxima and five equivalent to eight per cent overload. The average coal consumption for all purposes was 1.98 pounds per kilowatt-hour generated.

During a ten-day run in September, 1905, the results shown in Table 2 were recorded. The engines averaged eighty-seven and one-fourth per cent of the possible running time, and on fifty-four per cent station loading factor[1] the plant consumed 2.04 pounds fuel per kilowatt-hour, or 1.44 pounds per British horse-power hour. With coal of 13,500 British thermal

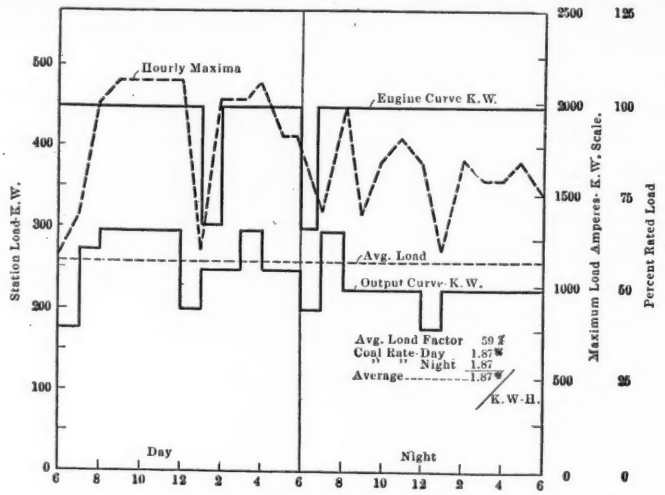


FIG. 1.—LOAD DIAGRAM GAS ENGINE PLANT, SEPTEMBER 25, 1905.

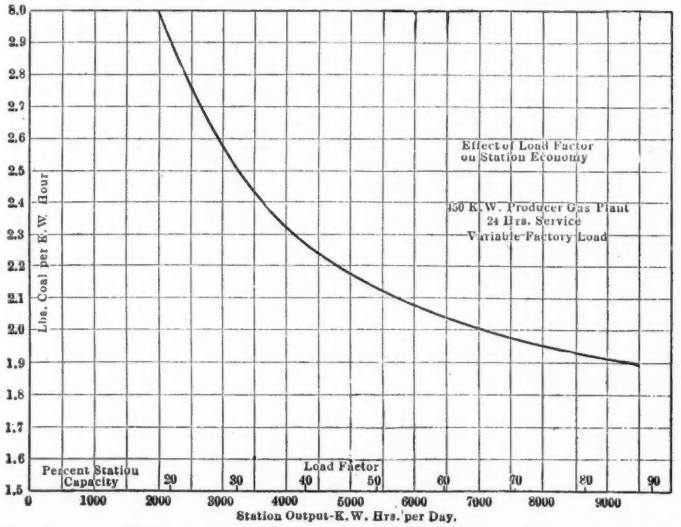

Effect of Load Factor on Station Economy
450 K.W. Producer Gas Plant
24 Hrs. Service
Variable Factory Load
Lbs. Coal per K.W. Hour
Percent Station Capacity
Load Factor
Station Output-K.W. Hrs. per Day.

FIG. 2.—RELATION OF FUEL RATE TO STATION LOADING FACTOR. (PLOTTED FROM OBSERVED DATA.)

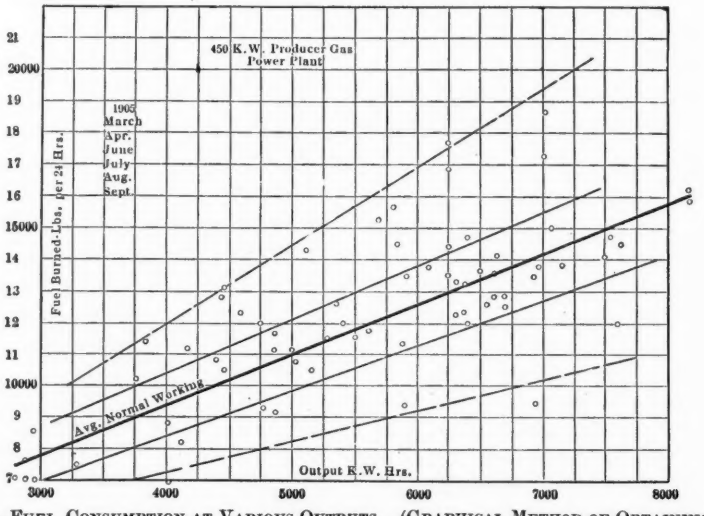


FIG. 3.—FUEL CONSUMPTION AT VARIOUS OUTPUTS. (GRAPHICAL METHOD OF OBTAINING TRUE AVERAGE.)

[1] This battery, however, was not placed immediately in service and does not affect the results presented in this paper except in the matter of capital costs

[1] Loading factor $= \frac{\text{Avg. 24-hour station load}}{\text{Rated capacity}}$

True load factor $= \frac{\text{Avg. 24-hour load}}{\text{Maximum}}$

units calorific value, the efficiency of this plant averages about 13.1 per cent, thus rivaling, if not excelling, the largest

modern steam power stations. On September 27, the fuel rate was 1.88 pounds per kilowatt-hour (or about one and one-quarter pounds per British horse-power hour), with sixty-two per cent loading factor, corresponding to a plant efficiency of over fifteen per cent.

The author has been deeply interested in the effect of the loading factor of a plant upon its efficiency and commercial duty. An unusually good opportunity arose in analyzing the results of this plant and the approximate relation is presented in Fig. 2. In order to obtain a closer average, the "shotgun" method (Fig. 3) was used, plotting total fuel per day to output. Barring some unusual results occurring in the early days of the plant, the average fuel consumption is approximately a straight line within observed limits. From this the average fuel per kilowatt-hour may be obtained, Fig. 4, and the relation approximates a rectangular hyperbola within normal ranges of load. The upper convex curve, Fig. 4, expresses the kinetic or absolute efficiency[1] of the station, and it is interesting to observe that this small plant normally operates with an efficiency[2] between twelve and thirteen per cent average.

higher loading factor—seventy-five per cent, the plant efficiency is thirteen per cent average, engines twenty per cent and producers sixty-five per cent. During an especially good day's run, as on September 27, the efficiencies were as follows: plant, fifteen per cent; engines, twenty-one per cent; producers, 71.5 per cent. These results indicate that the producer plant is, from an everyday operative standpoint, fully as efficient as a high grade boiler plant and frequently more so. It is certainly not more difficult to handle.

As to the cost of power the following analysis reveals a total cost of well under one cent per kilowatt-hour, including fixed as well as operating charges. At normal prices, coal[1] costs $2.30 per ton. Assuming an average daily output of 5,000 to 10,000 kilowatt-hours representing the probable minimum and maximum for full working days, and adding the fixed or capital charges amounting to about nine per cent on $91,650 (or $81,000 excluding the battery), the distribution of cost items is substantially that given in Table 3.

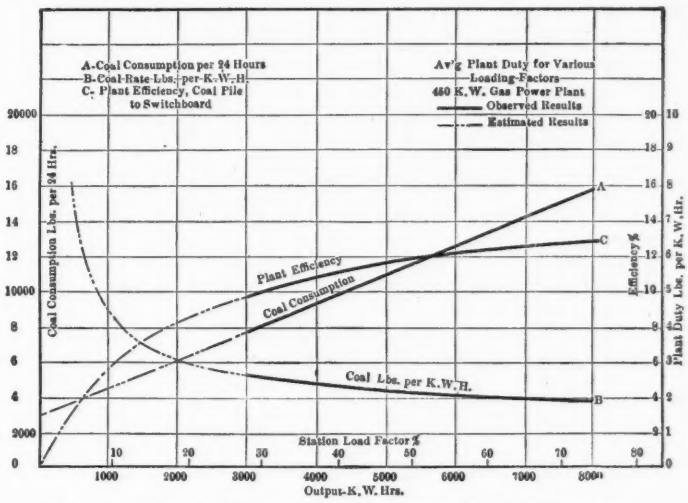

A-Coal Consumption per 24 Hours
B-Coal Rate Lbs. per K.W.H.
C- Plant Efficiency, Coal File to Switchboard
Av'g Plant Duty for Various Loading Factors
450 K.W. Gas Power Plant
Observed Results
Estimated Results
Coal Consumption Lbs. per 24 Hrs.
Efficiency %
Plant Duty Lbs. per K.W.Hr.
Plant Efficiency
Coal Consumption
Coal Lbs. per K.W.H.
Station Load Factor %
Output-K.W. Hrs.

FIG. 4.—AVERAGE PLANT DUTY AT VARIOUS LOADING FACTORS.

In order to emphasize the effect of loading factor Fig. 5 has been prepared showing the relation of both capital and operating costs to the station loading factor, the former plotted above and the latter below, the X axis. Total cost of power is given by the total ordinate. Observe the rapid change in costs on light loading, especially of fixed charges. Coal, on the other hand, remains fairly constant; labor a constant charge, increases rapidly on light loads, and supplies and repairs a variable charge, less rapidly. The importance of loading factor is well brought out by this diagram; e. g., the total cost of power is halved by increasing the loading factor from twenty-four to fifty-five per cent. An industrial or railway power

TABLE 2—OPERATING DATA.

450-KILOWATT PRODUCER-GAS POWER PLANT.

Date. Sept. '05.	Engine Hours Run.	Per Cent Full Day Run.	Output K. W. H.	Load—K. W. Avg.	Load—K. W. Rated.	Station Loading Factor.*	Fuel Used.	Coal per K. W. H.	Coal per B.H.P. HR.
20	71	98⅝	4,850	202	450	45	11,100	2.29	—
21	65½	91	5,275	220	450	49	11,400	2.16	—
22	70	97¼	6,550	273	450	61	12,700	1.93	—
23	45¾	63½	4,025	188	450	41.7	8,800	2.18	—
24 Sun	24	33⅓	2,250	187.5	450	41.6	†6,600	†2.93	—
25	70½	98	6,400	267	450	59	12,000	1.87	—
26	69¾	97	6,300	263	450	58	12,300	1.95	—
27	70½	98	6,700	279	450	62	12,600	1.88	—
28	72	100	6,700	279	450	62	12,900	1.92	—
29	70½	98	6,600	275	450	61	12,900	1.95	—
Avg.	63	87¼	5,565	243.4	450	54	11,330	2.04	1.44

Westinghouse vertical three-cylinder engines—Loomis-Pettibone producers.
* Loading factor = % continuous generating capacity.
† Includes extra coke used on Sunday for starting new fires.

From the above data and the measured efficiency of the gas engine, the efficiency of the producer plant may be roughly estimated. Assuming fifty per cent loading factor, the average plant efficiency is twelve per cent; as the efficiency of the engines is approximately seventeen per cent at this load (see Fig. 6), the producer plant operates at an efficiency of slightly above seventy per cent. With

TABLE 3—APPROXIMATE POWER COSTS.

	Minimum.	Normal.	Maximum.
Output, kilowatt-hours per day	5,000	8,000	10,000
Fuel, cent per kilowatt-hour	0.25	0.22	0.20
Labor, cent per kilowatt-hour	0.28	0.17	0.14
[1]Supplies and repairs (estimated), cent per kilowatt-hour	0.17	0.13	0.11
Operating costs, cent per kilowatt-hour	0.70	0.52	0.45
Fixed charges	0.45	0.28	0.22
Total costs, cents per kilowatt-hour	1.15	0.80	0.67

[1] These charges are estimated owing to absence of more accurate data and the comparatively short time plant has been in operation. Assume twenty-five per cent of total power costs at fifty per cent load factor, hence, the estimate is conservative.
It should be noted that were the plant to operate regularly at the lower load factors less labor and supplies would be required and the light load costs would be correspondingly reduced. The curves Fig. 5 are based on full plant in service operating continuously.

[1] Kinetic efficiency is defined as = Thermal equivalent of work done / Heat in coal

[2] Since the above observations were made the plant has been giving much better efficiency, the coal consumption averaging 1.8 per kilowatt-hour with an eighty-five per cent loading factor. This corresponds to a plant efficiency of over 15.4 per cent at the engine shaft or, fourteen per cent at the switchboard. Several runs averaging 1.55 pounds per kilowatt are recorded, equivalent to a plant efficiency of 17.7 per cent at the shaft, of 16.3 per cent at the switchboard.

[1] Buffalo, Rochester and Pittsburg bituminous run of mine, 13,500 B. T. U. per pound.

plant usually operates on about the latter figure, a moderate sized lighting pl[a]nt on the former; hence, the danger of indiscriminate comparisons of operating costs in power plant work.

Considering that the results above enumerated have been obtained from a comparatively small plant, operating under conditions by no means conducive to the attainment of the highest economies, the Depew plant offers a striking object lesson that should not fail of appreciation among engineers confronted with similar problems; and much credit is due the Gould Company through its consulting engineer, W. E. Winship, and its resident manager, J. O. Gould, for early appreciation of the advantages of gas power and efficient management of the Depew property. The author begs to acknowledge their courtesy and assistance in placing cost and operating data at his disposal.

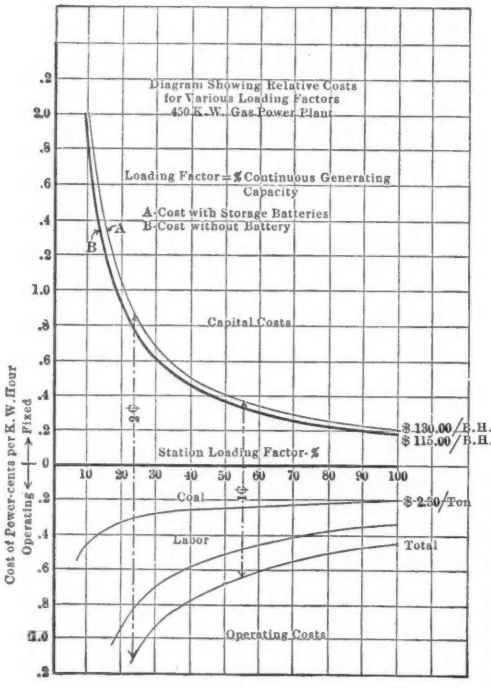


FIG. 5.—RELATIVE POWER COSTS AT VARIOUS LOADING FACTORS.

DESCRIPTIVE SECTION.

An excellent location has been chosen for the power plant adjacent to the Lackawanna Railroad main line. In the intervening space is a large semi-circular reservoir, serving the twofold purpose of a cooling pond and reservoir for general fire protection, and incidentally enhancing the attractiveness of the property to no small degree.

For convenience to coal supply the producer house is located several hundred feet in the rear, adjacent to a large metallurgical producer plant serving the steel furnaces. A single coal-handling system thus serves both producer equipments. This arrangement of buildings emphasizes the possibilities in gas-power work of separating, at any distance, the producer and gas-engine parts of a power plant for operative, or other, convenience.

Brick, steel and concrete are largely used as building material. In the producer house, where the fire hazard is, of course, considerable, no wood at all is employed, wall and roof being constructed of corrugated iron and charging floor of boiler plate. Spacious monitors in both buildings provide the very necessary ventilation and light.

Considerations of operating economy largely influenced the choice of gas engines for this plant where steam coal costs from $2.25 to $2.40 per ton, and gas coal about the same. At this price it was estimated that, although the difference between the steam and gas was small on half day working, for a twenty-four-hour day the latter's advantage was decisive.

The installation of three units of similar size and identical construction wisely avoided the duplication of parts which two or three sizes of engines would have occasioned. By the use of direct-connected units a very compact power-house arrangement has resulted, the total floor area per kilowatt being 6.1 square feet, and the net area of each unit with six-foot passageways 2.9 square feet per kilowatt.

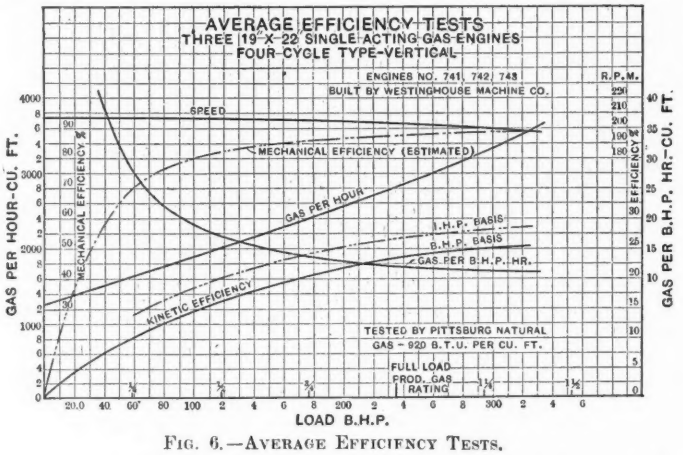


FIG. 6.—AVERAGE EFFICIENCY TESTS.

The efficiency of these engines as heat engines is well indicated by the appended results of tests[1] shown in the accompanying Table 4 and diagram Fig. 6. In the latter the upper concave curve represents the gas consumption per brake-horsepower under different loads and the convex curve, the kinetic or absolute efficiency.

The ability to convert into useful power over twenty-five per cent of the effective heat in the gas gives evidence of high efficiency. These engines operate on the four-stroke cycle involving constant quality of mixture and throttling governing.

A most important factor in the successful operation of the engines is the

TABLE 4—ENGINE EFFICIENCY.

AVERAGE OF TESTS.

Three 19-inch by 22-inch Single-Acting Four-Cycle Gas Engines.
Engines Nos. 741, 742, 743.

Load.	Over.	Full.	Half.	Remarks.
Brake-horse-power.....	325.3	239	121.3	By Prony brake.
Speed, R. P. M.	198	203	206.3	By counter.
Gas per hour	3,547	2,840	1,985	Corrected to 62 degrees Fahrenheit, 30 inches Hg.
Gas per B.-H.-P.-Hr.....	10.9	11.87	16.36	Corrected gas—no load—1,250 ft. per hr.
Heat value gas[1].....	920	920	920	Effective B. T. U. per cu. ft.
B. T. U. per B.-H.-P.-Hr...	10,030	10,910	15,050	
Brake kinetic efficiency..	25.37	23.32	16.9	B.-H.-P. basis.
Mechanical efficiency	89	87.5	82.5	Estimated.
Indicated kinetic efficiency	28.5	26.7	20.5	I.-H.-P. basis.
Speed variation, max....	4.2%			No-load speed, 206.6.
" " No full load..		1.8%		Average speed.
" " No half load.			0.7%	
Per cent full rating.....	138.4%	101.6%	51.6%	On producer gas.

[1] Pittsburg natural gas—Junker calorimeter.
Engines rated 235 B. H. P. on 130 B. T. U. producer gas.

[1] Made at the builder's works on natural gas which was at that time the only fuel available for testing purposes. As engines for producer gas are usually constructed for somewhat higher compression than those operating on illuminating or natural gas, their efficiency would presumably be slightly better on natural than on producer gas fuel; yet for commercial work a difference of 15 pounds in compression would scarcely be appreciable.

ignition apparatus. For increased security each igniter plug has two sets of points, each set independently connected. Should one set of points, through any cause, become unfit for use, a small double-throw switch may be reversed, thus turning the ignition current through the other points. In addition, three independent sources of current have been provided, all of the apparatus being contained in a central ignition cabinet. For starting, one of two eight-volt storage batteries is used. For running, a small one-half-kilowatt motor-generator unit is used delivering 110-volt current to the igniters through incandescent lamps, which furnish a valuable "tell-tale" of "open circuits," "grounded igniters," or "hanging fire" of igniters. These two sets of storage batteries are charged alternately through a bank of lamps from the motor-generator or from the main station bus-bar, one or the other set being always available in an emergency. By means of small double-pole switches at the igniter cabinets, throwing over from the low to the high-tension system may be instantly accomplished without in the least disturbing the engines. The ignition problem has thus been handled with great care in the provision of six individual combinations of current supply.

Starting of the engines is accomplished as usual by compressed air drawn from a pipe connection to a compressed air line in the works or from the relay compressor. Although only ninety to 100 pounds pressure is ordinarily carried; yet the engines may readily be brought up, cold, to full running speed, within thirty to forty seconds. With higher air pressure available, starting may be accomplished in even less time, as the mixture ignites more readily when quickly compressed, owing to the smaller opportunity for the dissipation of internal heat.

Another important part of the plant equipment is the circulating water system for cooling jackets, combustion chambers and exhaust valves. Motor-driven rotary pumps are ideally suited to this work on account of the moderate pressure required —about twenty-five pounds per square inch. Two of these pumps (one for relay) serve the engine plant, while a third, of the two-stage turbine type, serves the gas-producer scrubber in which a higher pressure is desirable. Although each pump is driven by a fifteen-horse-power motor, the power ordinarily required is considerably less than this, especially in moderate and cold weather when the quantity of water supplied to the engines may be largely reduced by throttling the pump outlets.

Previous mention has been made of a cooling pond. This has a normal depth of ten feet with a total capacity of about 1,000,000 gallons. It is approximately semi-circular in plan and is divided radially into two compartments to separate the comparatively dirty scrubber water from the pure jacket water. All make-up water used at the plant is delivered to the pure water pond through the engine jackets. Cooling water for the engine is drawn from near the bottom through a screen house, while the hot jacket water is returned to the surface of the pond, about 150 feet distant. During the progress of the water from inlet to outlet enough heat is dissipated to the earth and atmosphere to reduce the outlet water to the proper temperature.

Some trouble has been experienced with the gas gates, due apparently to cumulative deposits of carbon, and frequently it becomes impossible to seat the valves tight. In work of this class it would seem that a parallel seated quick-closing gate would be best suited, being self-cleaning, and the gas could be cut off almost instantly in case of emergency.

The engine exhausts all discharge into a cast-iron header running beneath the floor to a concrete exhaust well outside, serving as a muffler. Unfortunately, it is impossible to cool these exhausts by water sprays on account of the large amount of SO_2 in the gas. If water were used, as is the practice with natural gas, the piping would soon be destroyed by corrosion. As some thirty per cent of the total heat value of the gas is lost in the exhaust, radiation is a somewhat disagreeable feature, especially in warm weather.

Water cooling piping is simple, a manifold supplying all three cylinder jackets in parallel. Water enters at the bottom of the jacket, emerging from the top. A small pipe loop at the discharge end of the upper manifold with vent cocks at the top to break the vacuum serves to prevent the syphoning effect which under certain conditions might pull all the water out of the jackets, leaving nothing but steam. This vent is useful as a tell-tale showing stoppage of jacket water supply.

While the producer is undergoing renovation on Sundays the engines are also inspected in rotation, mixing valves flushed down with gasolene to remove lampblack deposits (likewise cylinders, now and then, to keep the packing rings free), valves are ground in and igniters replaced when necessary, jacket deposits cleaned out when obstructed to any extent, and the engines generally adjusted. Reducing valves are also cleaned, at intervals, from carbon deposits. Practically the only trouble experienced thus far has been the occasional cutting of an exhaust valve, presumably due to cumulative carbon deposits on the valve seats. The lampblack has also occasioned some difficulty in lubricating valve stems. Igniters, of course, wear down gradually, but extras are always kept on hand and repointed as fast as necessary. Usually one igniter will last from six to nine months without repointing. Since commencing normal operation engine repairs have been confined to these two items and are comparatively light considering the conditions of operation. Very little trouble has been experienced with lubrication, as the main working parts are automatically supplied by the splashing of oil.

A notable feature of the producer plant is that it is capable of gasifying bituminous coals without making quantities of tar. The process is intermittent, embodying the now more or less well-known system of passing the green hydrocarbon distillates through a secondary fire bed which has previously been brought up to the proper temperature by blasting with air. Since the plant was started, a fair grade of soft coal (B., R. & P. run of mine) has been used, averaging about 13,500 British thermal units per pound. Although this coal presumably contains thirty-five per cent of volatile, tar destruction in the producers is complete, but at the same time a considerable quantity of lampblack has resulted which has made it necessary to devise special means to handle this by-product.

Straight producer gas is not made directly, but water gas and air gas are made at alternate intervals of varying duration according to richness of the gas desired. The two gases are mixed in a single holder in the proportion generated. In this system two producers constitute a unit.

A feature of the system is that all steam required is generated entirely from the sensible heat of the gases coming from the producers which would otherwise be wasted in cooling water.[1] With the high "heats" necessary in the intermittent process this represents an important saving. The boiler, however, requires weekly cleaning.

The proper cleaning of the gas is a difficult problem, owing to the fact that lampblack does not easily adhere to a wetted surface as does ordinary cinder

[1] This condition, however, obtains only when the plant is heavily loaded. Running light it would be difficult to make sufficient steam to operate the producer auxiliaries. An air auxiliary boiler would have to be drawn upon.

dust. In this plant the gas first passes upward through a wet scrubber containing several tiers of small coke constantly wetted down by water sprays. A thin layer of dry excelsior is also used in the top tiers. Emerging from the wet scrubber the gas enters two large dry scrubbers filled with several tiers of excelsior and piped up in parallel so that the velocity of the gas is not only reduced, but also the amount of gas handled by each drier. Finally, an engine-driven Root's exhauster delivers the gas to the holder.

The present method of operating the producer plant requires an air gas run of ten to fifteen minutes, according to the demand for gas at the power plant, and a water gas run from one-half to three-quarters of a minute, the resulting mixture being well suited to power work. Calorimeter tests show the gas as made at the present time to average slightly above 100 British thermal units per cubic foot.

The entire producer plant is operated throughout the week by four men, two to a shift, with some additional labor on Sundays for cleaning. All the attendants were unskilled foreigners before taking up the producer work. During a half day shutdown of the plant on Sundays all renovating of the producer equipment is done; boiler tubes are cleaned, wet scrubber washed down, the excelsior in the dry scrubbers taken out and shaken free from lampblack, gas mains flushed out and a new fire started in the idle producer. At the same time another producer is taken out of service, fires are drawn, and during the week, after it has had an opportunity to cool off, the hard clinker, which adheres to the lining, is broken off. For the starting layer of a new fire bed, coke is used to the extent of some 3,000 pounds per producer, a sufficient quantity to affect the coal consumption of the succeeding day. If allowed to form to any extent clinker constitutes a frequent source of trouble in operating the plant, and it is important that the selection of coal be made with this in view.

A Memorial to Faraday.

On November 24 a tablet was unveiled at the Barnsbury, England, exchange of the National Telephone Company, to commemorate the fact that the building in which the exchange had been placed was formerly the meeting house of the Sandemanians, and that Michael Faraday had worshiped there from 1862 until his death in 1867. Faraday was an elder of this religious body, and the tablet, which was unveiled by Lord Kelvin, marks the position which he usually occupied on the platform. The unveiling took place with suitable ceremonies.

ELECTRICAL MINING NOTES.

BY SIDNEY F. WALKER.

ACCIDENTS IN MINES.

The issue of the report by the Home Office of the accidents that took place in mines during the year 1905 brings forward the question of how far electricity will tend to reduce those accidents, and how far new forms of accidents are being introduced by it. In particular, the question of explosions from defective safety lamps is a most important one. During the period covered by the report there were 108 accidents in coal mines due to naked lights, one due to a miner opening his lamp, and one due to a lamp being in a defective condition, these two accidents leading to the injury of ten persons, while the accidents due to the use of naked lights led to the injury of 148 persons. In addition to this, there were thirty-three deaths due to one accident, ascribed to the lighting of the mine, for which the precise cause is stated to be unknown. The question naturally arises, could some of these accidents have been avoided if portable electric lamps had been employed. There has always been a great objection among miners to the introduction of safety lamps, mainly because the light given is so much less than with a naked candle or lamp, and also because it so easily goes out.

When the incandescent lamp was first introduced there was a strong feeling among mining men, and electrical men, that the problem of lighting mines with safety had been solved, and very soon after, attempts were made to produce portable lamps. Mr. (now Sir) Joseph Swan was very early in the field, but though a number of inventors have attacked the problem, only one lamp has so far been introduced into practical mining work, the Sussmann, and this not to a very large extent. When the problem was seriously attacked it was found to be a very much more difficult one than was supposed. The weight offered a very serious difficulty. The early lamps, in which accumulators were employed, weighed as much as seven pounds and over. The Sussmann lamp weighs about four pounds. The ordinary Davy lamp weighs about three and one-half pounds, and there are some modern lamps weighing as little as two pounds. Several attempts were made to adapt primary batteries for the purpose. Schanschieff introduced a lamp worked by a primary battery, in which a mercurial salt was employed, the important feature of which was the resultant products were supposed to be more valuable than the initial substances with which the batteries were charged. This was correct in a sense, but it omitted the very important question of the cost of the collection of the resultant products. In practice also the Schanschieff lamp was found to be too delicate for mining work. The secondary battery, used in the Sussmann lamps, appears to have solved the problem fairly well, but it is only on condition that the course which has been adopted in the one or two collieries where it is in use is followed. The difficulty of the slopping of the electrolyte, which is a serious one in all forms of portable batteries, is solved in the Sussmann battery, by the use of an absorbent, finely divided cork or other substance. But the cells themselves are necessarily brittle, being made of vulcanite, and the tin vessel in which they are held, being made light, is also very quickly attacked by any of the acid which is spilt over them, and which it is very difficult to avoid. At the South Hetton and Murton collieries, in the County of Durham, where a large number of the lamps are in use, the problem has been solved by the construction being practically undertaken at the colleries themselves. The plates are made and formed, the cells made up and charged, and the whole thing put together. The arrangement is as follows: Each lamp when it comes out of the pit is dismantled, the cells carefully examined, the tinned iron containing case also, and the cells, if they are in good order, immediately put on the charging bench. When the miners are coming for their lamps cells that are known to be good are put together, placed in sound outer containing vessels with sound lamps, and so on. And the result has been apparently that the system has worked well and is very much liked, the light given being so much better than that of the ordinary Davy lamp.

But the above does not give the whole of the difficulties involved. The charge in the cells is sufficient to run the lamp, with a serviceable light, for about fifteen hours. In the County of Durham men are often ten and eleven hours between the time they leave the surface and the time they return to it again, the workings often being at a considerable distance from the shaft where the men work, and considerable time being taken up in going and returning. Further, there is always the chance of a man being left in the pit, and therefore it is important that the whole of the reserve in the cells should be kept intact as far as possible. Hence the switch, which is attached to the

Sussmann lamp, is by no means the least important part of the apparatus. But the space available makes the switch a very delicate affair indeed, and it is only by the skill which has been gradually acquired by the men at South Hetton and Murton, and elsewhere where the lamp is in use, that this difficulty has been overcome, assisted by the care in handling the switch, which the miners have learned by practical experience. The miners like the lamp, not only because it gives a better, a whiter light than the ordinary Davy lamp, but also because they can hold it in any position. The ordinary Davy lamp is an exceedingly sensitive apparatus. If it is held slightly out of the vertical it commences to smoke, and if it receives a sudden jar, is very apt to go out.

But there is yet another most important feature of the problem. The ordinary Davy lamp performs two offices, it gives light and it denotes the presence of gas. When fire damp is present in the atmosphere of the mine it is shown on the ordinary miners' lamp by elongating the flame. In testing for gas the deputy, as the official is usually called, or the fireman, reduces the flame of his lamp to a very small size, and he can then judge the elongation, and with skill he can tell approximately the percentage of gas present. The best lamps will denote the presence of gas from one-half per cent up to as much as six per cent, the explosive mixtures being from five per cent to fifteen per cent. That is to say, with less than five per cent of gas present in the atmosphere of the mine, it will not explode, and with more than fifteen per cent again it will not explode. The incandescent lamp used with the Sussmann, and any other form of portable electric miner's lamp, is necessarily unable to show the presence of gas. At South Hetton, Murton and other places, I understand the difficulty is overcome by providing the deputies with ordinary Davy lamps for the purpose of testing. But several attempts have been made to add a gas-testing apparatus to the portable lamp. One was added to the Sussmann lamp some five or six years ago, and it was exhibited at the office of the Sussmann Company in London, where they had a gas receiver into which they could place the lamp, the receiver being formed of a pedestal with a glass globe over it, fitted airtight on the pedestal, a gas pipe leading from the pedestal to the enclosure. The gas indicator consisted of spongy platinum, enclosed inside a cylinder, and there was a small incandescent lamp attached to the apparatus which gave a red light when gas was present. As exhibited under the conditions named above the apparatus worked very well. It was very interesting indeed to note the lamp when placed under the receiver, the red light appearing when the gas was turned on, as soon as a certain proportion was present. But unfortunately there was a serious flaw in the arrangement. Ordinary illuminating gas, with which the apparatus was tested, is not the same as the gas which is found in a coal mine. I do not refer to the difference in the actual composition of what is supposed to be illuminating gas, C_2H_4, and the composition of the gas known as fire damp, CH_4. For testing purposes these may be taken as practically the same. But the serious difference between illuminating gas, and mine gas is, illuminating gas is now very largely composed of hydrogen, and it is to the hydrogen that the Sussmann indicator responded. H. J. Prested worked at the problem afterwards, and produced a very sound apparatus, which I tested some years ago in a coal mine in South Wales. The testing apparatus was supplementary to the lamp. It consisted of a porous cell, similar to those used in batteries, the open end of which was closed by a diaphragm actuating an electric contact, which closed the circuit of a battery and the usual little red lamp. The force actuating the apparatus worked was the pressure produced by the difference in the rate of diffusion of different gases. When the porous cell was placed in a gaseous atmosphere the gas passed into the porous compartment quicker than the air could pass out, with the result that a pressure was exerted upon the diaphragm, the contact was closed and the red lamp lighted up. I understand that not much has been done with this apparatus, but it is evidently on these lines that the portable electric gas indicating apparatus will probably be arranged. The importance of testing for gas will be understood from the fact that it is a rule in several mining districts when a cap appears upon an ordinary Davy lamp, that is to say, when there is any elongation of the flame, as explained above, the whole of the men are to be withdrawn from the district, the working places, etc., where the gas is indicated, until the ventilating air current has diluted it down to safe proportions.

In South Wales, when I was carrying out the investigation mentioned above, a particular case was mentioned to me where the gas came away very suddenly and in large volumes from the working face at certain irregular intervals. No one knew when the gas would come away, but when it came the whole of the men were withdrawn from that face, and could not return until the gas had been removed. It should be mentioned that the very great improvement that has taken place in the ventilating of coal mines during the last twenty years has reduced the dangers from gas very largely. The enormous ventilating current hardly allows time for gas to accumulate in sufficient quantity to become a danger. The ordinary miner's lamps also have been largely improved. I have called the ordinary miner's lamp the Davy lamp in the remarks made above, but this is not strictly accurate. The old "Davy" and the old "Clanny" lamps are not often used now. In the modern lamp the flame is protected by gauzes and by metal bonnets, so that it will not be so readily extinguished when the miner is walking against the powerful air current that is so common in modern coal mines. The old "Davy" or "Clanny" lamp would go out. In addition, also, mineral oils are now used in a number of lamps, and they give a light at least twice as powerful as that given by the old-time lamp, and the flame is also very much more sensitive to the presence of gas.

Chicago Electrical Trades Exposition.

The following special days have been announced for the electrical show of the Chicago Electrical Trades Exposition Company, which will be held at the Coliseum, Chicago, Ill., next January: Monday evening, January 14, formal opening; Wednesday, Thursday and Friday, January 16, 17 and 18, annual convention of the Northwestern Electrical Association; Thursday, January 17, Ben Franklin day; Friday, January 18, Illuminating Engineering Society; Monday, January 21, telephone day; Tuesday, January 22, Sons of Jove; Wednesday, January 23, Thomas A. Edison day; Thursday, January 24, Electrical Salesmen's Association.

It is announced that a new storage battery which has just been completed by Mr. Edison will be exhibited and demonstrated for the first time.

The main floor of the Coliseum annex will be divided into four small theatres, which will form an "electrical midway." One of these will be devoted to new demonstrations with static apparatus and high and low-frequency currents. Another theatre will have a new electrical and mechanical creation called the Aurora Borealis. This will show some lighting effects invented and arranged by Edgar Healy, of Chicago. In the third theatre there will be arranged an electrical musical concert.

Thirty thousand square feet of space has been sold for general exhibits on the main floor of the Coliseum, but four spaces remaining unsold.

ENGINEERS AND THEIR WORK.[1]

BY SIR ALEXANDER B. W. KENNEDY.

In relation to science, I have always claimed for engineers a very high place, a place much higher than some of my purely scientific friends are disposed to allow them. M. Jourdain talked prose all his life without knowing it. So I really believe not a few engineers have spent their whole lives in scientific work while they were nominally only earning their daily bread in ordinary mechanical pursuits. It is not, however, so much that engineering is science as that the scientific spirit is often the basis of engineering, and that when this is the case, engineering becomes as truly scientific as any other branch of exact research, and none the less scientific because it is also the means of making an honest living. Engineering problems differ from ordinary academically "scientific" problems, partly in that they are much more complex, and consequently more difficult of anything like exact solution, and still more because—exact or inexact—some solution to them has always got to be found. Not only must the solution be found, but it has to be translated into steel and gun metal, as well as into £ *s. d.*, and any mistake will entail very much more serious consequences than a controversial paper in the *Philosophical Magazine,* or a letter in *Nature,* pointing out a wrong estimate of terrestrial radioactivity in prehistoric epochs.

It has been, no doubt, a source of regret to many who have passed this chair, as it is to myself, that as years go on and experience accumulates, one's work comes always more and more to deal with men and matters, with general schemes and methods, even with financial means and possibilities, and less with the directly mechanical problems which fascinated us when we were younger, and for the sake of which—probably—we took to engineering at all in the first instance. This is one of the penalties of old age—of engineering old age, at all events—and it is no use lamenting it. But speaking of the constructive part of an engineers' work and life, the part on which some of us look back as the very essence and joy of our careers, we can see that it consisted essentially of a long series of scientific problems to be dealt with, scientific questions to be answered. If the engineer has dealt with these by scientific methods and in a scientific spirit, if he has carefully marshaled his data, deliberately reasoned from them, recognized where they were incomplete, estimated the probable effect of their incompleteness upon his judgment and upon the result, and finally made his decision and taken his action on the whole matter as a logical conclusion from his previous reasoning, then, I say, the engineer is acting as truly as a man of science as if he were conducting a laboratory research with appliances and methods of exactness and precision unknown in actual professional problems.

But a word of caution—unnecessary to the experienced, but sometimes necessary nearer the start. The mere use of formulæ or of exact calculations of any sort is not in itself scientific. That man shows far more of the scientific spirit who recognizes when his data do not allow of the use of any exact formulæ, and who therefore reasons with what may be called mathematical common-sense, than the man who tries to force the facts to fit a class-room formula, and arrives at a result which satisfies the formula without recognizing that it bears no relation to the facts. The scientific engineer may use elaborate calculations, or he may not; a most important part of his science lies in judging whether to use them or not. Conversely, the man who calculates elaborately may be working scientifically, or he may not. The mere calculation is not scientific, and in certain cases may only be a cloak to essential defects both in scientific method and in technical perception.

To what extent do engineer and artist come in contact? It can hardly be denied that there are points which at least ought to be points of contact in their work, although their paths seem frequently to intersect rather than to be tangential, and the intersection is too often at ninety degrees! When engineering structures were confined to masonry bridges and pumping stations the matter was comparatively simple. It was difficult to make a stone bridge which was structurally efficient and actually hideous at the same time, and many of the older structures of this type left nothing to be desired by way of beauty of line. Whether a castellated or a quasi-Gothic building was the most suitable form for a Cornish engine-house may be questioned, but at any rate many of the pumping houses which once covered the country were not eyesores, and along with a not unpleasing exterior they combined complete internal suitability. It seems a little odd to us now—but it was certainly prompted by worthy motives—that even the machinery inside the houses was designed on architectural lines which were at least supposed to be lines of beauty. Even in the time of my own apprenticeship, it was universal for bedplates, entablatures and other large castings to be finished at their corners and angles with moldings more or less carefully designed according to classical models. Even moving parts such as the bosses of cranks, were ogeed round their edges, and no connecting rod of a stationary engine was considered finished without a double ogee ring round the middle of its length. Some of these details were survivals from cast-iron construction applied to a forgeable material, but they all died hard, like many less harmless customs. Penn's oscillating engines in the Thames steamers, which were at work until only a few years ago, had their cylinder-cover nuts of gun metal, each made with a turned ogee molding at their base like a fixed washer. And the entablatures of the same engines were wonderful in their wealth of detail.

We expect architects to consult and employ engineers to help them over structural difficulties and we may even scoff when they come to grief for not doing so. They are, on the other hand, quite entitled to turn the tables on us when they see that an engineer has put up a hideous barn which they could have transformed into a pleasing structure by their own special knowledge, and by that sense of form which it has been their chief business to cultivate, while we have been working at bending moments and breaking loads.

I have spoken of engineering in relation to art; it would perhaps be put down to cowardice if I did not say something of the relation of engineers and engineering to nature, especially as my mountaineering colleagues at the Alpine Club occasionally try to convince me that if I had any conscience I should renounce engineering altogether. We are sometimes guilty of disfiguring nature, I believe and regret. What is the extent of our guilt? Our interference with nature—that is, especially with natural scenery—comes practically under two heads—the erection of works for the utilization of water, either for use in cities or for power, and the construction of railways in mountainous or other beautiful districts.

The first is the easier to deal with. The conversion of upland valley bottoms into lakes by the construction of dams seems to me to be out of court at once. I am not inclined to admit that to cover boggy peat land with blue water is doing

[1] Excerpt from the presidential address before the Institution of Civil Engineers of Great Britain, November 6.

any harm to nature, or that a fine masonry dam is an eyesore. Moreover, if it is required for the supply of water to cities which could not obtain the water otherwise, it is a "work of necessity and mercy," and there is no more to be said about it, unless the engineer does his work with wanton disregard to all appearances, which, I believe, is never alleged. Water storage for power purposes can hardly be put upon quite so high a level, no doubt, and unfortunately such works are generally accompanied by pipe lines, which, it must be owned, are not things of beauty. But if the net result of the whole is to give employment to hundreds of men in places where hitherto no one could maintain himself, and to utilize natural sources of power hitherto neglected, for doing useful work on the spot where they exist, then I think an impartial arbitrator would say that the schemes were justified, even at the expense of ruling a straight line on the landscape. I admit that *tu quoque* is not argument, but some of us who love the hills best find, I think, that the scar along the hillside made for a deer road is every bit as disfiguring in itself as a pipe line, while it is infinitely less agreeable in all its suggestions. It may cheer the guilty engineer a little to think that if there is anything iniquitous in the utilization of water power, then, *à fortiori,* our whole nation is involved in the guilt accompanying the utilization of its coalfields, compared to which the construction of a few dozen pipe lines is a quite microscopical offence.

I am not saying anything to justify the putting down of a village where hitherto there has been no more than a ruined hut, because this seems to me to require no justification whatever. If we engineers can help to create places where a few of the overflowing thousands of our population can find healthy and remunerative occupation, we have nothing to repent of, even if, as I quite admit, the bare landscape would please some of us (myself certainly included) much better than the sight of the works and cottages.

There remains to be considered mountain railways, or railways in mountain districts. These really may be put into three categories. There come first the great lines, like the Simplon, which run through mountainous districts, and which are important means of continental communication. I have already suggested that it might, possibly, have been better for the world if it had stuck to stage coaches and had never gone traveling; but the world itself elected otherwise, and such works, therefore, require no justification. Also, I must add, that some of these—the St. Gothard and the Albula lines are examples—rather add interest to the landscape than disfigure it. I admit that in Switzerland I have often wished that the railways would burn smokeless coal, for in that case the trail of white steam would be a beauty in itself, and certainly more in keeping with the landscape than the trail of dust and filth which marked the course of the diligence along the high road.

I dare say that the feeling of contempt and dislike which we have for these things leads us sometimes, however, to exaggerate the actual damage which they do to nature. Happily nature is very forgiving, and has a way of covering up engineering iniquities so completely in a few years that they practically disappear and cease to trouble the eye. It is not so, unfortunately, with the works of a kindred profession. The railway to St. Moritz, for example, is almost out of sight, the railway station is perfectly harmless, but St. Moritz itself, spread in all its hideousness about a lovely lake side, is nothing less than a scar on the face of the earth—an absolute shock when you catch sight of it suddenly. For this, happily, we engineers can not be held responsible; I would gladly believe that Swiss builders employ no architects, if any one would only say so authoritatively!

With another profession, that of the law, we are brought by our daily work into very close connection, so close that in many matters it is necessary for the engineer to carry out his work in the most strictly legal spirit, however undesirable it would be for him to be his own lawyer. All engineering work of importance is carried out according to both a specification and a contract. An engineer prepares the specification and is practically responsible for the contract, while very often other engineers—from the manufacturing side—accept both documents and undertake to work to them. There is little doubt that the more strictly legal, which means in this case equitable, the conduct of both parties is in reference to these documents, the less is the probability that the aid of the purely professional lawyer will have to be called in later on.

On the manufacturer's side there is one chief and simple, but absolutely necessary, duty to perform in reference to these documents—namely, to read them. The duty is as simple and as obvious as "keeping your eye on the ball" in another phase of existence, and is just as often neglected. Hence many tears! If the contractor or manufacturer is dealing with a responsible and experienced engineer he may be sure that the documents are intended to mean what they say, and that, barring mistakes, they do mean it. If, therefore, he finds that he can not do what he is asked to do there is nothing to be gained by slurring it over. The only means of avoiding trouble is the raising of all doubtful points before the work begins so as to get them settled. If, on the other hand, the contractor is dealing with an irresponsible or inexperienced engineer, and no doubt there are such, it is all the more necessary that he should know exactly what he is asked to do. For in that case there may be meanings in the documents which only careful reading will discover, but which will certainly be taken advantage of, later on, against the contractor himself.

On the side of the engineer who draws up the specification, it is surely his duty, after drawing it up, after stating as clearly as possible his requirements, to endeavor to go through it from the point of view of the contractor, and make sure that there can be no reasonable doubt of the meaning of the words or phrases he has employed. This is every bit as true of the specification as of the contract, but whereas with the latter there is always legal help available, with the former the engineer has to trust to his own power of exact expression in saying just what he wants, and no more and no less than he intends to have.

Electrical Trades Society of New York.

At the eleventh annual meeting and dinner of the Electrical Trades Society of New York, held December 11, the personnel of the board of directors was changed slightly—two retiring members, P. M. Haight (Sprague Electric Company) and A. S. DeVeau (DeVeau Telephone Manufacturing Company) being succeeded by W. M. Franksen (Sawyer-Man Electric Company) and F. Stout (I. P. Frink), who were elected for a term of three years.

The following officers were elected for the ensuing year:

President, R. B. Corey.

Vice-president, W. E. Carmichael (Diehl Manufacturing Company).

Treasurer, B. H. Ellis (Manhattan Electrical Supply Company).

The other directors hold over for varying terms, and they are as follows: John H. Dale (The Dale Company); John Bray (Western Electric Company), besides Mr. Corey and Mr. Ellis.

Illuminating Engineering Society.

A meeting of the New York section of the Illuminating Engineering Society was held at the Edison Auditorium, New York city, Friday evening, December 14, to hear a discussion of "Light and Illumination," by Dr. Charles P. Steinmetz. Dr. Steinmetz spoke for an hour and a half extemporaneously, and during that time presented clearly the various problems met in measuring and producing light and in using it most effectively.

The speaker first explained that there is no physical difference between the types of radiation which are known as heat, light and chemical rays, other than that of frequency; that this classification is due simply to our physiological limitations; that what we recognize as heat and as light are the same thing, except that in the latter case the eye responds to the stimulus, and in the former it does not; that both these radiations, as are also the chemical rays, are transformed usually into heat when they fall upon an absorbing body, and that our recognition of a class as heat rays is due simply to the fact that it generally happens that the radiation of longer wave-lengths represent more energy and therefore appear to produce more heat when interrupted—for example, by the hand—than do the others; but the other radiations produce heat in the same way, though the amount thus produced is frequently too small to be detected by the hand.

The study of light and illumination is greatly complicated by the fact that it is a physiological effect and has no physical basis. There is, therefore, no true physical means of measuring or comparing light. While we may compare the quantities of energy represented by different radiations, these do not bear any relation to the amount of light produced. The eye itself reacts in a very complex manner, because it is sensitive to a limited range of rays—something less than one octave in frequency—and because its sensibility is different for different parts of this range. The same amount of energy in radiation lying in different parts of the spectrum produces very different effects upon the eye, as the latter is more sensitive to the green and yellow rays than it is to the red and the violet. Moreover, the sensibility of the eye depends not only upon the character of the rays, but upon their absolute intensity. There is, therefore, no method of comparing in a photometer lights of different color; in fact, the two things are different and, therefore, can not be compared directly. An indirect method might be used which consists in determining which color enables the eye to distinguish bodies more clearly. For eample, the lights may be used to illuminate a printed page, and the distances found at which they enable this to be read. The intensities of the illuminants might then be considered as proportional to the square of these distances, but this test fails because the sensibility of the eye, as mentioned above, depends also upon the absolute intensity. If a page with smaller print be substituted for the other it will be necessary to bring it closer to the eye to distinguish the printing, and the new comparison thus obtained will not agree with the previous one; and by using larger print, thus moving the page further off, a still different value will be found. In such comparisons it is necessary, therefore, to state not only the ratio of the two intensities of illumination, but the distance of the illuminated surface from the eye. If the illumination be intense, the red rays produce a greater effect; while if it be faint, the green cause the greater response.

Methods of producing light by means of incandescent solids and gases were then discussed, and it was shown that the efficiency may be increased by raising the temperature, since in this way the greater proportion of the radiant energy is given off in the visible spectrum, or by so-called selective radiation. It is necessary to define clearly what is meant by selective radiation. If it be meant by this simply that the relative quantities of energy represented by the different rays are not that given by the so-called black body, then certain solids do give such selectivity; but if it be meant by selective radiation that certain wave-lengths only are radiated, representing spectrum bands, there is no such thing as selective radiation from solids. The molecules of solids seem to be so closely compacted that there is not room for free vibration. Interference must take place, and therefore wave radiations of all wave-lengths are given out. In gases, however, the molecules are more widely separated and there is room for individual action. Gases do give selective radiation according to the second definition. To increase the efficiency of a light-giving source, if a solid be used, it is necessary then either to use a material such as tantalum, which may be heated to a very high temperature; or to use a substance in which the distribution of energy does not follow the black body law. Calcium is such a material. To increase the efficiency of the gaseous illuminant it is necessary to use a gas the molecules of which have a natural period of oscillation, which gives off a good proportion of the radiant energy within the visible spectrum. Here again it is necessary to consider the end sought, for if these visible rays lie at the extreme ends of the spectrum, the quantity of the light may be low, although the energy in the visible rays be large. If the visible rays lie in the yellow or green, the efficiency will be greater. But in seeking a high efficiency, the color of the light must also be borne in mind, for a green, although more powerful, may produce a poorer effect. Since the eye has been developed under the influence of sunlight, which we call white, this light must be taken as the standard, and for general purposes an illuminant should give off rays from all parts of the spectrum. This is possible, an example being the magnetite lamp the light of which is due to incandescent titanium vapor.

During this discussion Dr. Steinmetz threw out some interesting suggestions respecting the reason for our classification of radiations. The chemical rays are called so because of their marked action on certain unstable chemical compounds, and it seemed likely that this is a case of resonance, the natural period of the atoms of these compounds being approximately that of violet and ultra-violet light. On the other hand, the heat rays, being longer, may correspond more nearly to the natural period of molecules, which are necessarily larger and will vibrate more slowly than atoms. For the same reason heat rays probably play an important part in organic growth. Hence the preponderance of the colors red, yellow and green.

Turning then to the question of illumination, Dr. Steinmetz said that, after all, what we are seeking is not light, but the effects of light—illumination. This is a feature that has been overlooked by those developing sources of light. Their attention has been fixed upon increasing the efficiency and intensity of light sources. But an intense source of light may defeat the very purpose for which it was created, because the eye protects itself in such cases by closing the pupil. An intense source of light may then, particularly if it be in the line of vision, produce a less stimulus than one less intense. As a consequence, the lighting will be poor. This condition suggests that the end sought in lighting problems should be uniform illumination. But here again we may find ourselves at cross-purposes, because what we are really seeking is not illumination, but the effects of illumination, and a per-

fect uniformity of illumination would make it impossible for the eye to distinguish objects. In other words, the eye sees not by measuring the intensity of illumination received, but by comparison of different intensities; and if the illumination be perfectly uniform within a room, comparison is impossible. This difficulty has sometimes been met when indirect illumination is used—that is to say, when the light within a room is given by hidden sources which throw out a diffused light. Such methods are marked by an absence of shadows, and in such interiors, where the eye must depend upon shades and shadows for perception, uniform illumination, produced by diffusion, is sometimes unsatisfactory. The eye feels the need of shadows, and it strains itself, looking for them, and thus is tired and there is a feeling of dissatisfaction. Another uniform illumination may also be secured by directing the light given out by the lamps by the use of globes and reflectors, so designed as to distribute the light uniformly throughout the space. A marked characteristic of this method of illumination is the sharp, dark shadows cast by bodies in the room if there be not a number of sources of light. Here again the result may be unsatisfactory because the eye can not distinguish objects lying in the shadows and involuntarily strains itself to do so. The two methods of indirect and directed illumination may be combined to produce the best results.

But in studying illumination problems the end which is in view must be borne in mind. A solution satisfactory in one case is entirely unsatisfactory in another. Further, it must be borne in mind that the eye distinguishes not only by lights and shadows, but by color; and if the color effects are marked, uniform diffused illumination may be the best. The use which is made of the room must be borne in mind. For the home in general, there must be a combination of directed and diffused illumination for comfort, because here the eye sees by lights and shadows. In the ballroom, on the other hand, there is not so much need for directed illumination, because of the color variety. Again, in the shop or store the work which is to be done must be considered. In comparing colored goods a white light is essential, because daylight is our standard. If, however, it be sought to select goods and detect blemishes, a green or bluish-green light is the best, because dead organic matter has, in general, a brownish color which will appear black in a green light, but will be not so noticeable in an orange or red light. If, on the other hand, it be sought to mask defects, as may be the case in a ballroom, a reddish tinge will give the best effect.

It is of the greatest importance in illuminating problems to consider the reflection which takes place from the bodies on which the light falls directly. Frequently the reflection from the walls and ceiling of a room will increase the illumination three or four times over that which would be given by the direct rays only. The amount of reflection depends upon the color of the surfaces. A white surface reflects all the rays and hence will produce the greatest illumination; but white walls are not always satisfactory. In the home the standard of illumination must be daylight, but in this light the direct illumination comes from the windows, which have a low intrinsic brilliancy; and the diffused light coming from the walls is apt to be proportionally too great, so that a light tint on the wall will be more comfortable. In the machine shop or foundry the walls will, in general, take on a brown tint due to the preponderance of the elements iron and carbon; therefore, in such situations, a green light, which will not be reflected, is less satisfactory than an orange light. This has been found to be true when using mercury vapor lamp in foundries and shops. The same is true of city street lighting, where red and brown shades predominate. In parks and suburbs, however, where there is much foliage, a reddish light is less reflected than a green, and here a better illumination is secured with a light of the latter color. The illuminating engineer must, therefore, consider a number of features in selecting the proper method for any particular situation. He must distinguish between diffused and directed illumination, so as to get the lights and shadows sought; and he must bear in mind the color of the light which he selects so as to produce the proper effect. Heretofore little attention has been paid to these factors, but they are now receiving very careful study.

Dr. A. E. Forstall took issue with Dr. Steinmetz upon one point of the address. The former had said that the Bunsen flame is not luminous, because the mixing of the gas with air before burning enables the carbon to be burned up so quickly that it does not give any appreciable light. Dr. Forstall said that in the luminous flat flame the hydrocarbon is broken up and carbon is burned as such, but in the Bunsen flame the combustion is one of hydrocarbons, and since carbon is not burned as such, it does not give off the characteristic light. He emphasized the necessity for keeping the intrinsic brilliancy of light sources low, as the object is rather to get light to the eye than to secure bright illumination.

P. S. Millar gave the results of certain experiments which have been conducted at the Electrical Testing Laboratories in the comparison of lights of different color. When a comparison was made of a lamp giving a reddish light with one giving a green, such as the mercury vapor, by means of the Lummer-Brodhun photometer, with the sources of light at distances varying from ten to fifty feet, and with an illumination of from one to twenty luces, the Purkinje effect—that depending upon the different sensibilities of the eye to different intensities of different colors—caused a difference in the ratios of the two lights as great as thirty per cent. Substituting the Bunsen photometer, this difference was reduced to fifteen per cent, and when the flicker photometer was employed the difference disappeared. This seemed to indicate the possibility of devising means for comparing lights of different color. Mr. Millar called attention to the poor examples of illumination met not only in public places, but in the offices of companies interested directly in supplying light and lamps. He thought it was time for the society to stop scolding the public and turn its attention to its own members.

W. H. Gardner said that Mr. Millar was correct in saying that the lighting companies gave instances of poor illumination, but he pointed out the fact that they are selling light and illumination, and their object is to attract attention, which they do by exhibiting brilliant sources of light.

G. V. Williams said that the efficiency of an illuminant is not as important as the effect which is sought, and that psychological effects are involved, as well as physiological. The effect must be one agreeing with the mood. Too brilliant illumination is harsh and spoils artistic effects. Softer illuminations are more pleasing, and these should always be used in the home.

V. R. Lansingh pointed out that the effect depends as well on the quantity of light as on the intensity of illumination, and too much light coming from large sources may be objectionable.

In closing the discussion, Dr. Steinmetz accepted Mr. Forstall's explanation of the combustion of the Bunsen flame, saying that, while expressed a little differently, he had the same idea in mind. He questioned whether the flicker photometer would really offer a solution of the problem of comparing lights of different color. In his opinion this photometer produced an effect depending rather upon the average energy reflected to the eye than upon the character of the different illuminants. He thought that the photometer measured a physical rather than a physiological effect. Red and yellow lights easily produce after effects which persist, but this effect is very hard to secure with green and blue lights.

The meeting was then adjourned.

Comparative Cost of Cooking with Various Fuels.

BY CHARLOTTE D. SEAVER.

The results set forth in the following table show the relative average expenses of cooking by electricity compared with the different fuels in use, for the same kind and character of cooking operations, the time in each case being based on one hour.

COMPARATIVE COST OF COOKING WITH VARIOUS FUELS.

Source of Heat for Cooking.	Electricity.	Coal.	Gas.	Gasolene.	Kerosene.
Amount of energy or fuel required for given cooking operation	1.032 K. W.-H.	10.5 lb.	20 cu. ft.	0.0832 gal.	0.078 gal.
Cost consumed	$0.04 per K. W.-H.	$7.00 per ton.	$1.00 per 1,000 cu. ft.	$0.15 per gal.	$0.14 per gal.
Cost of cooking by given source.	$0.0413	$0.0367	$0.02	$0.0124	$0.0109

From the foregoing results the advantages and disadvantages of cooking by electricity may be summarized as follows: at the rate of four cents per kilowatt-hour it would cost double that of gas fuel; and, at the prices ordinarily paid for electricity, it would cost at least six times that of gas or coal, which are the fuels most commonly used. This fact, together with the initial cost of the apparatus required, would appear to forestall its general adoption at present. While the first cost of cooking utensils seems high, yet an outfit may be obtained for $50, consisting of an oven, a broiler, a griddle, a six-inch stove and a flat-iron; or the following combination: a griddle, two six-inch stoves, an oven and a flat-iron. Either of these outfits would serve for the necessary cooking for an ordinary family of from three to six people. A very complete outfit, comprising a slate-top table with several outlets for electrical connections, with cords and conductors and the following utensils: an oven, a broiler, two stoves, a coffee percolator, a quart pot and a large kettle, may be purchased for $110. This is not so much in advance, therefore, of the ordinary kitchen outfit as it might appear. Moreover, these cooking vessels are of nickeled copper, which is of longer life and is more easily kept in good order than are ordinary utensils. Those utensils that lock on to the stove give the quickest service on account of the close contact. For highest efficiency those water heaters are the best in which the heating coils are embedded in the bottom. The efficiency of a heater of one quart capacity is about eighty-seven per cent.

[1] From an article on "The Economics of Electric Cooking" in the *Clarkson Bulletin*, published by the Clarkson Memorial School of Technology, Potsdam, N. Y., October.

The advantages of electric cooking from the standpoint of sanitation and saving of labor consist in the fact that there is no smoke, flame nor soot, and, of course, no ashes nor dust arising therefrom. When in use there is nothing to indicate the presence of heat, for the apparatus has the same appearance as when cold. While the cooking goes on there is little or no appreciable rise of temperature of the air surrounding the utensils. There is no vitiation of the atmosphere and practically no radiation of heat into the room, which would be of great advantage in the summer. The apparatus may be readily accommodated on a table, thus doing away with the bulky range and its fuel. There is no labor in maintaining uniform heat; no danger of fire or explosion, no danger of personal injury or electric shock, as the voltage of 110, which is usually employed, would not produce more than a slight burn on the fingers. Electricity is quite readily obtained for heating and cooking and may be used, as has been shown, at a reasonably high efficiency. The articles are of superior quality. The work of the oven, for example, is as nearly perfect as possible. The time required, from the turning on of the current to complete the baking of a given article, for instance, may be determined to a certainty. Results which have been found the best by experience may be reproduced easily with the electric oven. It will not burn the top nor the bottom of the food but heats quickly and uniformly. No particular attention is required to be given to what the oven contains, for there is no need of changing a pan containing bread or cake to get a more favorable position. Every loaf of bread or cake may be obtained uniform in height, while all are of that delicious brown so highly desired.

The time required for cooking various articles of food is practically the same as by other methods of heating. It takes the same length of time to boil a potato of given size in one way as in another, to soften the fibre of meat, or to convert dough into perfectly baked bread. The gain in time in electric cooking comes from the heat being so quickly available. For light housekeeping such as is the custom in small city apartments, and in larger houses during the summer months, no other method presents so many desirable features. Gas, gasolene and kerosene are of course extensively used, but with the disadvantages of greater heat in the room, unpleasant odors, vitiation of air, comparative uncleanliness, and always with some danger.

Notwithstanding all its advantages, both sanitary and labor-saving, the expensive utensils and the high price charged per kilowatt-hour for the service will nevertheless tend to make the general use of electric cooking of slow growth. We firmly believe, however, that it will win its way into public favor. Electricity in the near future will no doubt be so generated as to be brought within the means of almost all of the smaller home circles. The greater comfort and convenience, on the other hand, appeal strongly to the woman doing her own work, either from choice or necessity. Indeed, it is not too much to expect that electric heating and cooking may offer at least a partial and perhaps a complete solution of the domestic-service problem, and thus meet one of the highest functions of modern science in preserving the home from the disintegrating influence so imminent whenever some help can not be obtained for the most ordinary operations of housekeeping and homemaking.

Boston Grants Independent Telephone Franchise.

The board of aldermen of Boston, Mass., on December 13 granted a franchise to the Metropolitan Home Telephone Company. The question of granting a franchise has been before the aldermen since last May, and several hearings have been held on the subject. A few weeks ago the board voted to give the petitioners leave to withdraw, but later reconsidered its action. This action by the board has been the subject of considerable comment. The company received its charter from the secretary of state on May 21, 1906. The capital stock is fixed at $5,000,000, and a number of prominent business men are said to be stockholders. It is announced that the company's plans involve the expenditure of $10,000,000. The ambition of the company is to open the way for independent connections throughout the New England and Middle Atlantic states.

Meeting of the Provisional Organization Committee of the Cooperative Electrical Development Association.

Last March, it may be remembered, a joint meeting of a number of leading men from all branches of the electrical trade was held in New York. At this meeting a very representative committee was appointed to cooperate in developing the plans and in perfecting the organization.

W. M. McFarland, acting vice-president of the Westinghouse Electric and Manufacturing Company, chairman of this committee, called a meeting for December 13, 1906, at the Imperial Hotel, New York city, to further consider the objects, plans, results and organization of the association.

At the morning session J. Robert Crouse presented a paper dealing with the work and results, which was fully discussed.

This was followed by a further paper on the commercial plans formulated for the future, which was likewise discussed from various points of view.

At 1:30 P. M. the gentlemen present lunched together, and at 3 P. M. assembled for the afternoon session.

The first part of this session was devoted to a reading of the proposed constitution and by-laws, after which a general and lively discussion of the entire proposition was indulged in.

The sense of the meeting was crystallized in the following resolution introduced by Walter Cary, of the Sawyer-Man Electric Company, which was unanimously passed:

"*Resolved,* That it is the sense of this meeting that the commercial programme outlined for the Cooperative Electrical Development Association for 1907 and the future is along sound lines, and gives good promise of highly profitable returns to all concerned.

"It is the further sense of this meeting that immediate steps be taken to perfect the organization of the Association and to prosecute its commercial plans vigorously, pursuant to which the chair is requested to appoint three committees, of five members each, as follows: Committee on constitution and by-laws; committee on membership assessments; committee on commercial programme."

The chair appointed the following committees:

Committee on constitution and by-laws—E. E. Jackson, chairman; A. D. Page, General Electric Company; Walter Cary, Sawyer-Man Electric Company; F. J. Newbury, John A. Roebling's Sons Company; W. W. Freeman, Edison Electric Illuminating Company, of Boston.

Committee on commercial programme—F. S. Terry, chairman; W. C. Bryant, Bryant Electric Company; R. S. Hale, Boston Edison Illuminating Company; A. L. Doremus, Crocker-Wheeler Company; E. W. Gillmer, Peerless Electric Company; F. Bissell, the F. Bissell Company.

Committee on membership and assessments—J. S. Anthony, chairman; Walter Cary, Westinghouse Electric and Manufacturing Company; W. W. Freeman, Edison Electric Illuminating Company, of Brooklyn; Charles B. Price, Pettingell-Andrews Company; James R. Strong, president National Electrical Contractors' Association.

These committees will in the immediate future, formulate and submit their detailed report to the chairman of the joint committee, so that at its next meeting the Cooperative Electrical Development Association may be formally and finally launched.

In the evening at 8, the *confreres* sat down to a banquet, over which J. S. Anthony, of the General Electric Company, presided gracefully.

The more serious business of the day having been dispatched, the evening was given over to the cultivation of closer acquaintance and general good fellowship.

The following is a list of those in attendance:

W. M. McFarland, Westinghouse Electric and Manufacturing Company, Pittsburg, Pa.; Walter Cary, Sawyer-Man Electric Company, New York, N. Y.; W. C. Bryant, Bryant Electric Company, Bridgeport, Ct.; J. S. Anthony, General Electric Company, New York, N. Y.; A. D. Page, General Electric Company, Harrison, N. J.; E. S. Keefer, Western Electric Company, New York, N. Y.; A. L. Doremus, Rodman Gilder, Crocker-Wheeler Company, Ampere, N. J.; E. W. Goldschmidt, Wagner Electric Manufacturing Company, St. Louis, Mo.; F. S. Terry, National Electric Lamp Company, Cleveland, Ohio; F. J. Newbury, John A. Roebling's Sons Company, Trenton, N. J.; E. E. Jackson, New York, N. Y.; W. H. Blood, Stone & Webster, Boston, Mass.; W. W. Freeman, Edison Electric Illuminating Company, of Brooklyn, N. Y.; John F. Gilchrist, Chicago Edison Company, Chicago, Ill.; R. S. Hale, Edison Electric Illuminating Company, Boston, Mass.; J. E. Montague, Buffalo & Niagara Falls Electric Light and Power Company, Niagara Falls, N. Y.; F. M. Tait, Dayton Lighting Company, Dayton, Ohio; F. Bissell, the F. Bissell Company, Toledo, Ohio; Charles B. Price, Pettingell-Andrews Company, Boston, Mass.; James R. Strong, president National Electrical Contractors' Association, New York, N. Y.

The following gentlemen who were expected to be in attendance were unable to be present; Arthur Williams, president National Electric Light Association, New York, N. Y.; Henry L. Doherty, New York, N. Y.; Gerard Swope, Western Electric Company, Chicago, Ill.; O. A. Stranahan, Allis-Chalmers Company, Milwaukee, Wis.; A. T. Clarke, American Circular Loom Company, Chelsea, Mass.; E. W. Rockefellow, Western Electric Company, New York, N. Y.

American Institute of Electrical Engineers.

The 212th meeting of the American Institute of Electrical Engineers will be held in the assembly room of the New York Edison Company, No. 44 West Twenty-seventh street, New York city, on Friday, December 28, 1906, at 8:15 P. M. Ray P. Jackson, electrical engineer of the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., will present a paper entitled, "Recent Investigation of Lightning Protective Apparatus." The paper will be discussed by the following members of the Institute: Charles P. Steinmetz, Frank G. Baum, Harold W. Buck, Ralph D. Mershon, Percy H. Thomas, David B. Rushmore and H. B. Alverson.

The Chicago Traction Situation.

It is announced that the long controversy between the city and the street-car companies is practically at an end. The basis of a settlement of the transportation question has been agreed upon along the lines demanded by a majority of the city council and the voters. It is understood that $50,000,000 will be divided between the two big companies, on the basis of approximately $29,000,000 to the Union Traction, and $21,000,000 to the Chicago City Railway.

The Independent Telephone Company of Chicago.

Interests which have secured control of the Chicago subway telephone system, it is announced, will incorporate under the title of the Independent Telephone Company of Chicago. Equipment to the value of $4,000,000, for a telephone service of 100,000 subscribers, will be ordered at once.

REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE

The Presence of Neon in Radioactive Minerals.

A search has been carried on for some time by R. J. Strutt for the rare gases along with helium in the radioactive minerals. The early results were negative, but a recent test showed a trace of neon in two minerals—zircon and cyrtolite. The amount of the gas could not be determined accurately, but it was judged to be about one-three-hundredth part of the helium. The separations were made by Dewar's charcoal method, and it is possible that with the greater skill attained by the author that a repetition of previous experiments will indicate the presence of neon in other helium-bearing minerals which have previously been tested. On the other hand it is possible that the presence of neon is connected with zirconia, as both of the above minerals contain it. —*Abstracted from Nature (London), November* 29.

A New Type of Continuous-Current Dynamoelectric Machine with Commutating Poles.

While the use of a commutating pole assists in securing favorable conditions for commutation, it is contended by V. A. Finn that the changes thus secured are not as great as are usually assumed, for although a suitable winding placed upon these poles may provide a commutating magnetic field of sufficient intensity, the use of these poles does not affect appreciably the leakage lines passing from the armature laterally through the pole pieces, because the introduction of these poles does not in any way affect the magnetic reluctance of these paths. The auxiliary pole will therefore not be able to compensate for the armature reaction and thus prevent all magnetic field distortion. To secure this result a modification of the magnetic field, indicated in Fig. 1, has been made. This is a two-pole field with auxiliary poles intermediate between the main poles, but the two main poles are completely divided centrally so as to provide two entirely independent magnetic paths. The effect of this is to introduce another air-gap in the leakage path, thereby greatly increasing the reluctance of this path and reducing the field distortion; and there is a further advantage, since the commutating flux may be caused to add itself to the flux through one of the main poles, and thus assist in compounding the generator. To secure this end it is only necessary to arrange the commutating pole unsymmetrically with regard to the main poles. This is indicated in Fig. 2. With such an arrangement there is no necessity for placing windings on the commutating poles. Fig. 2 also shows the method of increasing still further the reluctance of the leakage paths by splitting the main poles. With a design of this kind the two independent magnetic field sections may be supported by end shields, from which they are insulated magnetically. This is a design which allows the use throughout of maximum densities and of an air-gap limited only by mechanical considerations and a comparatively small number of ampere-turns on the commutating poles. It also simplifies somewhat the problem of ventilation.—*Abstracted from the Electrician (London), November* 30.

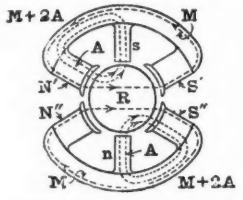


FIG. 1.—ARRANGEMENT OF COMMUTATING POLES.

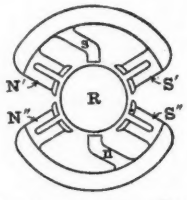


FIG. 2.—ARRANGEMENT OF COMMUTATING POLES.

An Automatic Circuit-Breaker.

If a round carbon rod be placed upon two similar rods held parallel and separated from one another by about one centimetre, and each of the latter be connected to one pole of a battery giving about eight volts, a bright glow appears at the points of contact of the rods and a loud note is heard. This phenomenon has been investigated by Chr. Rice, who finds that the rods form an automatic circuit-breaker giving a very high period of interruption. By connecting into this circuit the primary winding of an induction coil a powerful discharge takes place between the electrodes of the secondary. By shifting the superimposed rod on the other two, so that it is nearly balanced upon one of them, resting but slightly upon the other, the sparks increase and the tone rises in pitch, showing that the frequency of interruption has been increased. During this discharge the upper rod is seen to vibrate rapidly from side to side. The action is supposed to be due to the alternate heating and cooling of the point of contact.—*Translated and abstracted from Physikalische Zeitschrift (Leipsic), December* 1.

Measurement of Temperature Rise in the Windings of Electrical Machinery.

A comparison is made here by F. Loppé of the rules for determining temperature rise in the windings of electrical machinery in force in the United States, in Germany and in France. In the United States the temperature coefficient of resistance is taken as 0.42 for each 100 degrees centigrade, and the normal temperature of the room is taken at twenty-five degrees centigrade. If the actual temperature differs from this the temperature elevation should be corrected by one-half per cent for each degree, so that a temperature in the test room of thirty-five degrees should make a decrease of five per cent in the observed value. The rules call for a temperature determination by resistance measurements, except for squirrel-cage windings. The German rules say that, except for field windings excited by continuous currents and windings of stationary elements, the increase in temperature must be determined by means of a thermometer. The increase in temperature of the field windings should be determined by resistance measurements, and the temperature coefficient of resistance is taken as 0.004. The Association Français prescribes the determination of temperature rise of windings, whenever possible, by simultaneous resistance measurements and thermometer readings, and the higher value shall be taken. The temperature coefficient of resistance is taken as 0.004. If the winding to be measured is thick the

rise in temperature will be considerably greater than that indicated by the thermometer, and the value determined by resistance measurements may be ten or twenty per cent greater. For thin coils wound on iron in which hysteresis losses are taking place, the thermometer will generally indicate a temperature slightly higher than that given by the resistance measurement. The author shows the application of the various rules to an assumed case, and finds that the values thus determined differ but slightly from one another.—*Abstracted from L'Industrie Électrique (Paris), November 25.*

The Irreversibility of the Heusler Alloys.

An investigation has been made by Bruce V. Hill to determine to what extent the Heusler magnetic alloys are reversible as regards temperature effect. Iron and nickel alloys, which become non-magnetic at about 700 degrees centigrade, regain their susceptibility upon being cooled to low temperatures. Upon reheating the same cyclic change takes place. The magnetic bronzes, on the other hand, are but little affected by cooling to low temperatures, as the susceptibility depends rather upon the temperature from which the specimen has been cooled before the test is made. If heated to a temperature slightly above that of transformation the susceptibility at room temperature is found to be smaller than when the latter was first cast. On cooling successively from still higher temperatures the susceptibility at ordinary temperatures increases as the temperature from which the metal has been cooled rises. These results were obtained with four different alloys made by melting together copper-manganese alloy and aluminum. Chemical analysis of the samples showed that a good deal of manganese had been burned away. The percentage of copper varied with the sample from sixty-three to seventy-four; that of aluminum from twenty-two to thirty-four; and that of manganese from one to four. These samples were placed successively in a magnetizing field maintained constant at thirty-eight C. G. S. units. Upon increasing the temperature the intensity of magnetization decreased at an increasing rate, falling to zero at about 320 degrees. Upon allowing the latter to cool, the intensity of magnetization rose, but only to about thirty per cent of its original value. Upon reheating to a still higher temperature the intensity of magnetization again fell to zero at about the same temperature, and remained at this point; and, upon cooling again, retraced practically the path for rising temperature, though rising to a higher value of susceptibility at the temperature of the room. Three of the four samples behaved in substantially the same manner, the original intensity of magnetization being for one, 175, and for a second, 123. After heating the intensity lay between forty-five and fifty-five. One sample was non-magnetic and only showed magnetic properties after being crushed in a mortar. The results indicate that the susceptibility of the alloy at room temperatures decreases as the temperature to which it has been heated rises, up to a certain point. If heated beyond this there seems to be a slight increase in the intensity upon recooling. The alloys do not regain their magnetic properties at the higher temperatures. If it be assumed that the molecular state of the metal is in great measure that naturally stable at the higher temperature, due to the retardation or non-occurrence of certain allotropic changes, then it must be supposed that there are different molecular arrangements of the metals constituting the alloy at different temperatures; and the relations existing at high temperatures allow the transformation of the manganese from the beta to the alpha state to take place more completely than in the molecular groupings at lower temperatures. The experiments seem to indicate that the phenomenon of magnetization is rather a molecular than an atomic property.—*Abstracted from the Physical Review (Lancaster), December.*

Electrical Equipment of a Newcastle (England) Railway Warehouse.

The Northeastern Railway Company, of Great Britain, put into use in October last a new freight warehouse at Newcastle-on-the-Tyne, in which a complete system for handling materials has been installed. All the machinery in the warehouse is driven by electric motors and has been designed for the rapid handling of freight with a minimum expenditure of manual labor and time. Energy for operating the system is obtained from the Newcastle Electric Supply Company at 400 volts, continuous current. This is controlled from a central switchboard in the warehouse, from which the energy is distributed to the various machines and lighting circuits. The electrically driven machinery comprises ten cranes, two transporters, six jiggers, two wagon hoists, one wagon traverser, forty-two capstans, making sixty-three machines in all. These are driven by ninety-five motors of the series-wound, enclosed, multipolar type, with the exception of those in the capstans, which are compound wound, so as to enable them to deal with the variable load with slight variation in speed. The method of handling freight is as follows: In the basement, which is a low-level freight station, cars are drawn by means of capstans into either of the two hoists at the ground level, and lowered sixteen feet to the rail level of the basement, where they are drawn off the hoist table to a traverser, which crosses the basement of the warehouse, and sets the wagon opposite any of the four roads as required. The wagon can then be moved by means of the sixteen capstans and four turntables with which the basement is equipped, to any desired position, while two pillar cranes with a radius of nineteen feet lift materials into and out of the wagons placed within their radius; and two traveling cranes fitted with revolving jibs of twelve feet radius deal with the lorries placed near them as well as the platform over which they travel. These cranes, although they only span a platform twenty feet wide, command an area nearly forty feet in width. The ground floor, which is a high-level station, has six rail tracks running into it, fed by sixteen capstans, with eight turntables inside the building and ten capstans and four turntables outside. The four traveling cranes on this floor are provided with revolving jibs covering a span of forty-eight feet six inches. The jib radius is eleven feet, and the length of track 300 feet. There are also two cranes here with a seventeen-foot radius of jib. Two conveyers on the second floor work across the building and can pick up a load from any of the six ground-floor roads or from the two outside roads and place it on either of the floors above by working through suitable hatchways. The jiggers can pick up from or lower onto the roads outside and serve the first and second floors, while two of them serve short lengths of the third floor. They have a travel of twenty feet inside the warehouse. The jib cranes are equipped with motors ranging from one to six horse-power, the hoists with fifty-horse-power motors, the traverser with a twenty-six-horse-power motor, the capstans with motors of the same size, the traveling cranes with one-and-one-half and fifteen-horse-power motors, the jiggers with one-and-one-half and ten-horse-power motors.—*Abstracted from the Electrical Review (London), November 30.*

Methods of Getting New Business

A DEPARTMENT DEVOTED to the COMMERCIAL DEVELOPMENT of CENTRAL STATIONS

Managers are Invited to Contribute Suggestions for Methods of Increasing the Demand for Electric Service

ADVERTISING ELECTRICITY—III.

BY FRANK B. RAE, JR.

ADVERTISING CAMPAIGN.

It is almost impossible to stipulate what shall or shall not be done in seeking business by means of advertising. Local conditions and business ethics alone make the boundaries of our endeavors. The idea that any given amount of clever printed matter constitutes an advertising "campaign" is wholly erroneous. Advertising is not printing; it is an educational process. The stock "campaign" is successful only in the most limited degree. It may be compared with ready-made clothes in that it serves well and is cheap if one can only be sure of a "fit." This statement goes counter to the rules of the game as laid down by men of standing in the advertising field, but nevertheless it is subject to confirmation by any one capable of analyzing his own, or better still, another company's local conditions. Such an analysis will bring home sharply this truth—there is no cut-and-dried rule for undertaking an advertising campaign, any more than there is a hard and fast rule for treating physical illness.

The material at hand for carrying on an advertising campaign consists in letters, personal or circular; booklets and folders of more or less decorative make-up, novelties of infinite variety, general publicity by means of bill-boards, painted signs and street-car cards, newspaper advertising and legitimate news items. These, roughly, are the ingredients of the campaign and it rests wholly upon the local conditions to decide in what proportion and amount one or several or all of them shall be used. In making such a decision, personal preference and prejudice must be cast to the winds. It makes not one iota of difference what you, gentle reader, like or dislike. What the firm wants are results — contracts — profits. Whatever will get those results without violating the ethics of the business, is good advertising, whether you like it or not. Whatever will not give results is bad advertising, no matter how many of your friends congratulate you on the cleverness of your work.

THE USE OF CIRCULAR LETTERS.

The most common and at the same time the most altogether difficult medium of advertising to handle is the circular letter. The value of the circular letter as a means of advertising is in direct ratio with the ability of the writer and printer to produce a letter which shall appear to the reader to be a *bona fide* personal communication. There is no doubt that the circular letter under letter postage, reaches its destination. A man's mail will find him where the most resourceful solicitor can not penetrate. It will receive attention where the most tactful solicitor would fail. It is the most effective device in the advertising man's bag of tricks.

At the same time, no medium of advertising requires more complete and all-embracing cleverness to handle; for its whole effect lies in the advertiser's ability to deceive the reader into believing that a letter, printed by thousands and addressed to all classes of prospects, is a personal communication intended solely and specifically for one individual. It will be seen that this is no slight achievement. The mail of every business man is lumbered with this very class of material, and so suspicious has the public become that dictated personal letters are frequenty mistaken for circulars and consigned to the waste-basket.

The responsibility of the circular letter rests about equally between the writer and the printer. The writer must find a reasonable cause for addressing the prospect and must impress him with the naturalness of his communication. The printer, for his part, must produce an imitation so perfect that nothing but microscopic inspection will develop its real character. If an imitation is not perfect, it is not worth the stamp required to post it. A plain type circular, well displayed, will bring more business and leave a better taste in the mouth of the man who receives it, than an imitation which carries the brand of fake on its face. The reader has but to ask himself how much importance he attaches to circular letters which come to his desk, to realize the necessity of using in his own advertising, letters which will pass the careful scrutiny of business men to whom a poor imitation would be an insult.

BOOKLETS AND FOLDERS.

It would seem that with all the millions of booklets which have been produced within the last century or two there should have been developed a few fundamental rules, or schedule of correct procedure, upon which such advertising material might be based. Apparently, however, the only limitation is set by the booklet maker's own peculiar ideas and these, frequently enough, are a matter more of personal preference than of cogent reasoning.

In taking into account the use of booklets in an advertising campaign, the most primary consideration is that of distribution—how are we to place this material in the readers' hands? The second consideration should be to decide exactly the scope and purpose of the booklet, in order that it may not transgress beyond a fixed limitation. The third factor is quality, which, generally speaking, should be as high as is reasonable in view of the class of business it is designed to stimulate or create.

A few arbitrary laws would seem to govern in the matter of distributing booklets. It is well to remember, first, that only short and very catchy material should be used as enclosures with bills or letters. It is almost instinctive with the receiver of such matter to throw away the advertisement. Only the most casual glance is given to make sure that it is not of personal interest. The booklet must win attention in that instant of pause.

Where the books are to be distributed by solicitors or third-class mail, it is well to have them quite elaborate in order that they may receive consideration from their intrinsic beauty, cleverness or value. When a solicitor personally delivers a piece of advertising it is expected that it will complement the selling argument which he has made, giving, perhaps, fuller and more interesting data.

The scope of the booklet is the most difficult to handle discreetly. As a rule, the amateur in advertising endeavors to tell too much. As the preparation of such a book progresses, additional points come up, which seem absolutely necessary to include. Thus, from an eight-page booklet, designed to stimulate, let us say power business, there gradually develops a very cyclopedia of technical data on power and motor applications, so obviously overdoing the matter that the book fails from excess. The rule here is summed up in

two words—brevity and suggestion. Since the whole subject can not be covered, let a few vital, salient points be made in such manner as to prove the value of your service while suggesting its illimitable applications.

The mechanical preparation of advertising booklets is a matter which runs the whole gamut of types, plate-making, printing, paper and binding. On any one of these subjects, there exist whole libraries of information, so that it is obviously without our province to touch upon any one of them. It may be said, however, that the printed matter put out by an electric light company should be as good as the class of business solicited will warrant. No slightest detail should be overlooked. If the funds available will not admit of making the proposed work wholly excellent, then a smaller piece of advertising matter should be employed. A four-page folder well done will bring better results than a twenty-page book which looks cheap, or in which any detail is less than perfect.

NEWSPAPER ADVERTISING.

In the 1906 Question Box of the National Electrical Light Association the advisability of newspaper advertising was questioned and the answers proved that sometimes newspaper advertising pays and sometimes it does not. About the only law one may safely follow in reaching a decision is the law of common sense. For example, in a town where there are probably not over half a dozen private plants, it is palpably unprofitable to offer arguments designed to put the isolated plant out of business. In a town where metropolitan newspapers divide patronage with the local press, it is obvious that newspapers will have comparatively little value. Under the most favorable circumstances and in anything less than a metropolis it must appear self-evident that advertising for power business in the newspapers is a waste of money and effort. There are, however, no substantial reasons why any of these things are so—and sometimes they are not so. Exceptions abound.

In many cases newspaper advertising is of the greatest advantage; among these may be cited the moderate sized city, fairly remote from large centres and where rivalry among merchants is keen. In such communities the local newspaper is carefully read by all classes and is a first-rate medium for reaching a desirable market. Likewise in cities having any considerable foreign population, the national paper of that particular people will frequently give astonishing results. The reason would seem that such papers generally have the most absolute confidence of the people to whom they appeal and this confidence extends to the advertiser who uses its columns.

NEWS MATTER.

The old policy of secrecy upon the part of public service corporations is one wholly foreign to modern American ideas. The policy of to-day may profitably lean towards openness and frankness in matters of company news, and this will lead to much gratuitious advertising of a most beneficial sort. The public is interested in its public utilities; moreover, the public feels as if it had a right to know something about them. Finally, if the public knew the scope of the activities of the average utility, it would realize the difficulties under which public service corporations labor and would at once be more just and charitable in its attitude. Every day there develop items of real news value which may be turned over to the local press. These items may be of a personal nature touching officers of the company; they may be facts concerning extensions and betterments, or they may take the form of demonstrations of new appliances for the benefit of editors or reporters. All such items are welcome in the paper of the average sized city.

BILL BOARDS AND CAR CARDS.

The use of bill boards and car cards is in the nature of general publicity. Nothing very definite can be expected of it by an electric light company, except in cases where it is necessary to publish broadly and quickly some specific announcement.

Should rates be materially reduced notice of the fact could be given wide and effective publicity on bill boards. Notice of temporary displays or demonstrations may also be given by bill boards to advantage. It is wise for the electric company in a fair-sized city to use illuminated sign boards at strategic points, in order to stimulate similar advertising by others. The public feels confidence in the firm that will "take its own medicine," and the adoption of such methods will react favorably.

The street-car card is in the same class with bill boards. Obviously there is no opportunity in either case for extensive argument; rather, it is auxiliary advertising—useful in conjunction with a more direct campaign, but almost barren of traceable returns.

PROGRAMS AND SCHEMES.

The lighting company which enters upon a serious advertising campaign should set its face resolutely against all publicity by means of programs or similar schemes. Where the program is for a church affair, society outing or labor entertainment, the advertisement is solicited, not upon the value of the medium, but as a contribution to the "cause." It is a species of charity solicitation wherein as a rule, both the organization and the advertiser lose. For if such matters be investigated it is too frequently found that the solicitor usually pockets the proceeds —or the major portion of it—giving only a shoddy program free to the organization. When it is not plain graft such a contribution is charity and should be charged as such on the books. Advertising is for profit. No profit—to the advertiser—was ever known to result from schemes.

THE USE OF NOVELTIES.

Generally speaking, the advertising novelty is of doubtful value. Its chief purpose is not to stimulate inquiries, nor create desire for the product so advertised, but rather to compliment or placate customers, present or prospective. An advertising novelty is not an argument, but a bribe designed to put the receiver under a certain slight obligation. The amateur is frequently misled by the appreciative comment with which such novelties are received and by the fact that they are preserved for a considerable time. But advertisers who have sunk much good money into such novelties soon learn that whatever good-will the novelty may generate generally finds lodgment where it brings no direct returns, other than increased demand for free favors.

The most effective novelty, perhaps, is the calendar, but these should not consist of a pretty picture wholly irrelevant to the subject advertised. They should, if possible, suggest the business they are intended to promote, should carry arguments, not merely the sender's business card. Of other novelties there would appear to be no end, but their advertising value is wholly a matter of time and chance, and we think can seldom be recommended as having any real part in a serious campaign.

Illuminating Engineering Society of New England.

The Illuminating Engineering Society of New England met at the American House, Boston, November 13, 1906, the meeting being called to order by Dr. Louis Bell. A paper was read by W. E. Holmes on the "Flaming Arc." He gave some very interesting experiences of this lamp in its earliest stages of commercial use. The paper was discussed by Messrs. Cowles, Marks, Bell and Gifford. A. T. Sampson read a paper, written by Major E. L. Zalinski, on "Fixture Design" which was discussed by Messrs. Ryan, Clifford, Bell and Marks. Professor H. E. Clifford read a paper by F. N. Olcott upon "Fixture Location in Residence Lighting" upon which a discussion followed, participated in by Messrs. Cowles, Clark, Bell, Holmes and Sampson.

INDUSTRIAL SECTION

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS

Automatic Starting Compensator for Induction Motors.

Simple as is the construction of the squirrel-cage type of induction motor, the fact that the larger sizes require a suitable starting device has prevented the simplicity of the motor from being widely

FIG. 1.—COMPENSATOR, SHOWING OIL-IMMERSED SWITCHES.

taken advantage of when automatic methods of control are essential. The automatic starting compensator recently perfected by the General Electric Company for three-phase induction motors will therefore greatly broaden the field for motors of this type, especially in pumping and similar work.

The automatic starter consists essentially of a compensator with two oil-immersed switches, the starting and running positions of which are controlled by two solenoid magnets, inter-connected by a time-limit relay device. One solenoid switch connects the motor to the compensator, while the second solenoid throws the motor directly on the line. The time

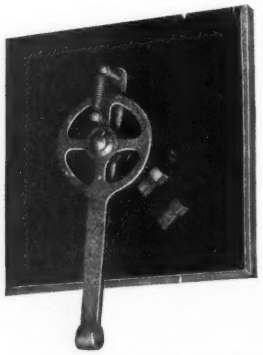


FIG. 2.—SINGLE-POLE FLOAT SWITCH.

allowed for letting the motor come up to speed between the two operations is provided for by an adjustable dash-pot auxiliary switch. An interlocking device prevents both solenoid switches being closed at the same time. The motor is started by closing a small push-button switch.

The arrangement of these various parts is shown in the illustration, Fig. 1. At the left is the solenoid operating the compensator switch; at the right the solenoid which throws the motor directly on the line, while the relay switch is mounted in the centre.

The feature which contributes most to the successful operation of the device is the arrangement of the main solenoid switches by which the operating circuits are broken when the solenoid core is drawn up into the closed position. The cores as they rise, trip a switch in their energizing circuits so that the solenoid coils do not remain in the circuit. Each core is held in the closed position by means of a detent controlled by a small auxiliary solenoid, which when energized merely serves to hold the core up, floating in its magnetic flux. When the motor is running the only coil energized is this small auxiliary solenoid which controls the detent of the line switch solenoid.

Thus all operating circuits except the main line switch and the one small solenoid are open, and there is no disagreeable humming or energy wasted in auxiliary circuits. The solenoids are all wound for single phase so that they can be operated from one leg in the circuit.

In starting up a motor a small push-button switch is closed, energizing the left-hand solenoid which throws the compensator into circuit. At the same time the auxiliary relay switch is lifting its core against the retarding action of the dashpot, and after an adjustable interval of time this switch disconnects the starting solenoid, energizes the right-hand solenoid and thus throws the motor directly on the line. When the motor is running the compensator is cut entirely out of the circuit.

To stop the motor the push-button switch is opened, the small auxiliary solenoid core falls on the detent, thus disconnecting the line switch and leaving all spool circuits opened until the push-button switch is again closed. Failure of current acts in the same way as opening the push-button switch.

This automatic compensator can be supplied where the remote starting and stopping of three-phase induction motors is necessary. In pumping, the push-button switch may be replaced by a float or pressure switch. In the first case a single-pole float switch (Fig. 2) can be used, and when the water is to be controlled by pressure the type M. C. governor, similar to that employed in air-brake work, can be substituted for the push-button switch. These are but two of the many ways of applying the automatic compensator which will suggest themselves.

The automatic compensators described are built for circuits employing a potential up to 550 volts. For circuits operating at higher potentials the General Electric Company provides a series transformer to step-down the voltage for the energizing coils. The compensator coils are provided with the usual taps for adjustment to various starting conditions. External enclosed switches are used in the circuit when the motor is across the running side of the compensator switch.

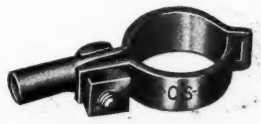
Educating the Public to a Better Knowledge of Illumination.

The Holophane Glass Company, New York city, for some time has been carrying on a campaign of education, which, it is safe to say, has very materially increased the knowledge of the general public on the subject of illumination. V. R. Lansingh, general manager of the company, as has been announced in the ELECTRICAL REVIEW, has given many lectures in different parts of the country on the subject in general. Since last fall, however, A. J. Marshall, of the engineering department, has been calling on the large central stations in different cities, carrying with him lantern slides and arranging for lectures on illumination, not only to the central station solicitors, but also, in general, arranging for the public as well as dealers and contractors to be present. Only incidentally is the Holophane system brought in, and it is not given any more prominence than any other system of illumination. This work is of great

value to the electrical industry, and is being appreciated by the central station companies. While the Holophane company's schedule is pretty well filled up, the company will make every effort possible to place its facilities in this direction at the disposal of companies with whom arrangements have not been made.

An All-Copper Ground Connection Clamp.

The Chase-Shawmut Company, Newburyport, Mass., has placed on the market the Shawmut all-copper ground connection clamp. This clamp is offered as a means of overcoming the dangers ordinarily associated with secondary distribution systems. The clamp is made of



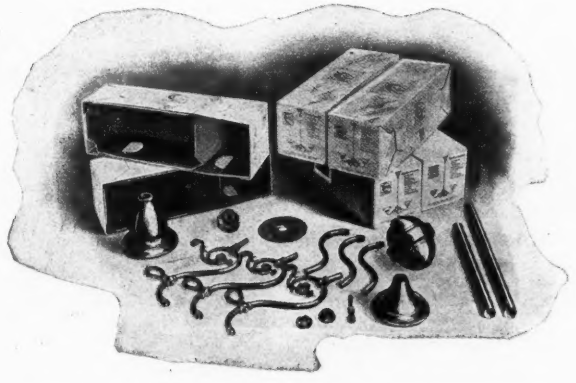
ALL-COPPER GROUND CONNECTION CLAMP.

two pieces of copper held together with an iron bolt, and is made to fit any size of pipe from one-half to three inches in diameter. A terminal lug is provided, large enough to take a No. 4 wire. This clamp offers simplicity, strength and maximum contact area.

Electric Fixtures.

The Cleveland Gas and Electric Fixture Company, of Cleveland, Ohio, is the manufacturer of a general line of lighting fixtures, with sales departments in Cleveland, Ohio, and Pittsburg, Pa. The company is about completing the erection of a new factory at Conneaut, Ohio, with about 75,000 square feet of floor space and a full equipment of improved machinery. The company will manufacture a staple line of what is designated as the "C" line of box fixtures, which will comprehend all requirements in low and medium-priced fixtures, and to manufacture which the new factory is being provided. A portion of the factory is already in operation, and while the company is at the present time oversold on these goods, it expects to meet all demands with prompt shipments by January 1 and thereafter. The idea of putting up fixtures in as small a package as fourteen and one-half by four and one-half by four and one-half inches is an innovation in the fixture trade, and is being well received by the buyers.

The accompanying illustration shows the arrangement which is being made with this line of box fixtures. This method ensures the keeping clean and untarnished of the fixtures until ready for installation. There can be no lost parts, as each separate part of the fixture is carefully wrapped and put into the package ready for assembling. The boxes are made of strong cardboard, divided into compartments for the various parts of the fixture. All the parts, except the iron pipe, are compactly packed in the box. Each box is labeled with the fixture number and finish. A patent has been applied for on this idea.



METHOD OF ASSORTING AND PACKING "BOX" LINE FIXTURES.

Sixty-five Mile Interurban Line in Texas.

Contracts have been let by the Texas Traction Company for the equipment of a sixty-five-mile electric road between Dallas and Sherman, Texas. The new line will parallel the existing steam road between the two cities and will be one of the longest electric roads in the state. While the apparatus is standard direct current throughout, the equipment, in some respects, presents several features of interest.

The country through which the new line is laid out is flat and rolling, there being no grades exceeding one per cent and a maximum curvature of but three degrees. In order to have a clear headway for operating cars, a private right of way has been established by the company, so that the run between Dallas and Sherman will be made in two hours and thirty minutes. This schedule includes a fifteen-minute run within the city limits of Dallas, where the cars must necessarily be operated at lower speeds. While the main traffic will be of an express nature, stops have been provided about every two miles to take care of the local travel.

Fifteen car-equipments will be provided to maintain the initial schedule. These will be of the standard interurban type, each fifty feet long, and equipped with four GE-73 (seventy-five-horse-power) standard direct-current motors equipped with the Sprague-General Electric Type M system of multiple-unit control. Each car will be further provided with General Electric air brakes and compressors.

Power for the new road will be generated by steam at McKinney, a town located about midway between Dallas and Sherman. The main power station equipment will include two 1,000-kilowatt Curtis steam turbo-generators working under a steam pressure of 150 pounds at the throttle with 125 degrees superheat. The turbines will operate condensing. Current will be generated at 2,200 volts and twenty-five cycles and stepped up for transmission to 19,100 volts. For exciting the fields, two thirty-five-kilowatt generator sets will be provided. The compactness and low maintenance charges of these machines adapts them particularly for exciting units.

The three-phase current from each of the turbo-generators will be transformed in a set of three 330-kilowatt, air-blast transformers. One transformer of the same capacity will be installed as a reserve. To supply air for cooling, duplicate blower sets will be furnished, one set being driven by an induction motor, the other by a direct-current motor. Each blower will have a capacity of 10,000 cubic feet.

One of the special features of interest in the new road lies in the rotary converter equipment. Six substations will be provided, including one at the main station and a portable equipment. This last mentioned substation comprises a special car containing a 300-kilowatt rotary converter, air-blast transformers

and suitable switching apparatus for cutting into the transmission system wherever necessary. The portable substation renders unnecessary the duplication of rotary converters at the fixed substations, for the portable equipment can be shifted to various parts of the line and used as an emergency station or auxiliary in case of need.

The substations will be inter-connected by high-tension transmission lines, operated initially at 19,100 volts. Eventually, however, a transmission potential of 33,000 volts will probably be used and for this purpose taps will be provided for Y-connection of the transformers. With the few exceptions noted the new line follows, in general, the standard direct-current practice of the General Electric Company.

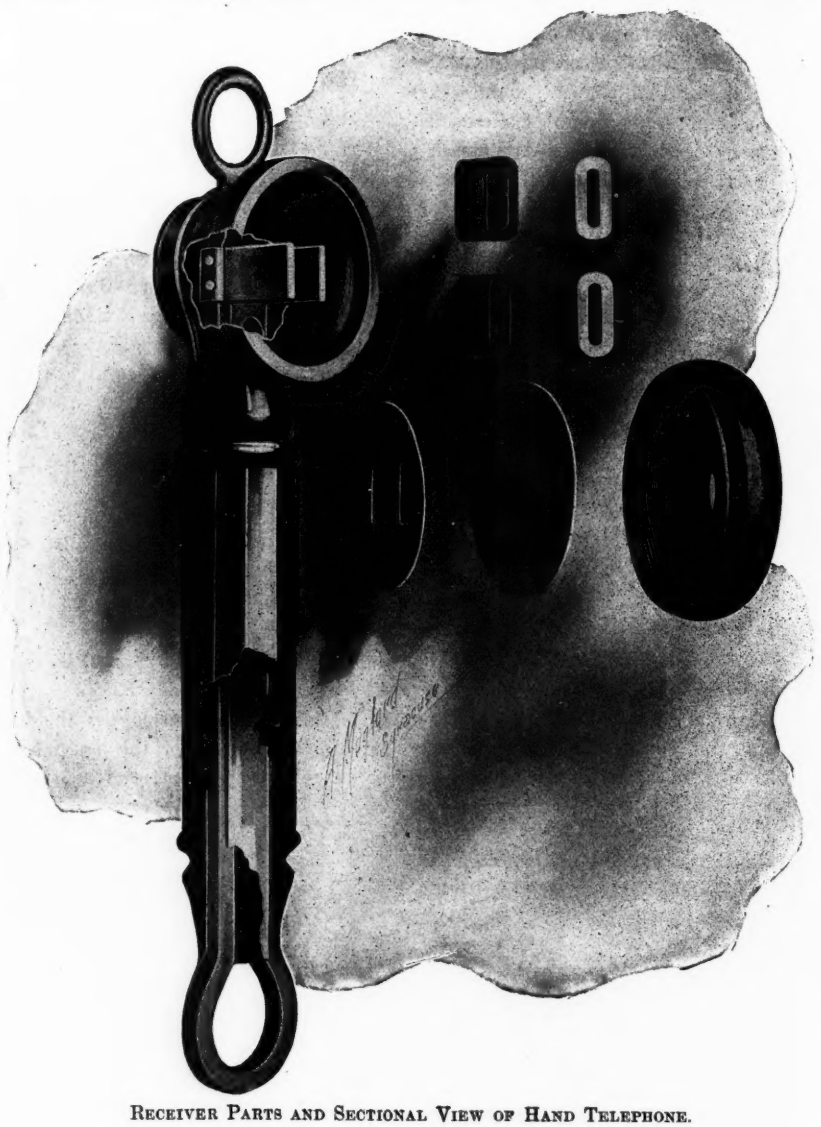
A New Telephone Instrument.

Some eighteen months ago, at the organization of the Wire and Telephone Company of America, Rome, N. Y., it was announced that this company had acquired the patents of S. C. Houghton and F. M. Potter, Jr., and much interest has been expressed in telephone circles as to the product of this company. The Wire and Telephone Company of America has just made its first announcement in reference to the product of its telephone manufacturing department, and it is believed that much interest will be manifested in the telephone equipment shown herewith, which is one of the many types of apparatus which will be manufactured by this company under the name of "Easophones."

As may be seen from the accompanying illustrations the instrument is compact and of pleasing appearance. The apparatus has been designed to satisfy the demand for a hand telephone both for local and long-distance service. The instrument is equipped with a solid back, long-distance transmitter, long horseshoe magnet receiver. A noteworthy feature of the design is the hard steel magnet, which is made unusually long, and which forms the backbone of the instrument. This magnet is of the horseshoe type, and extends from the receiver to the transmitter; and the poles of the magnet, the cores of the electromagnets in the receiver, the solid suspending ring and the transmitter are rigidly interlocked. This unites all the metal parts in one solid form. Over the whole the hard-rubber handle and receiver shell are molded in one piece and vulcanized, producing a telephone that is practically indestructible. In making up the instrument the channel formed by the two arms of the long magnet is sealed with a brass covering, and after the parts have been properly adjusted and the case molded about them, a hole is drilled through the receiver case and the brass covering and the connecting cords drawn through the channel formed by the arms of the magnet.

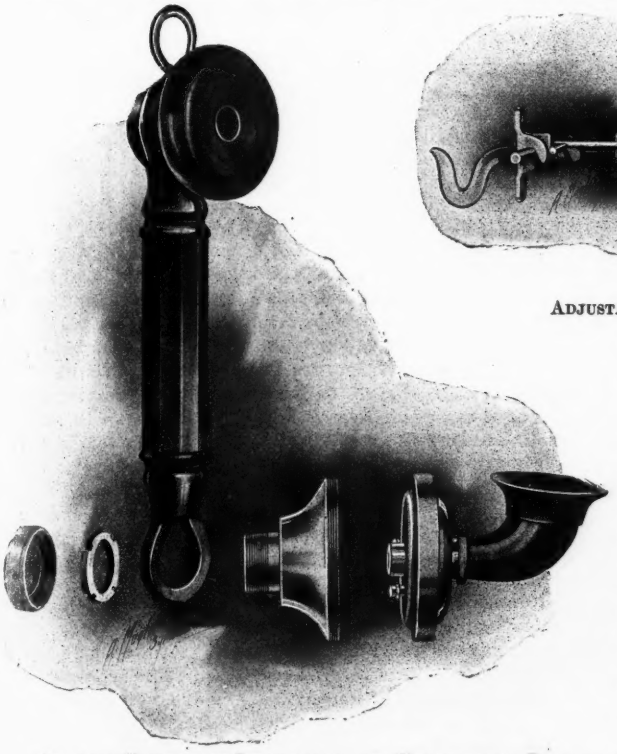
In forming the handle and receiver case a solid block of vulcanized rubber is built up to make a support for the slip coils, which are placed over the cores of the receiver electromagnets. The leads are then soldered to the coils, and over the slip coils a fibre protecting washer is placed, this being held in position by thin metal escutcheons. The receiver case is then threaded, the magnet cores machined to a positive adjustment, the diaphragm slipped in place, and the receiver cap screwed on. A unique feature of the receiver cap is a sweat ring, which is molded around the aperture, and which prevents the accumulation of perspiration from dripping into the receiver case.

The transmitter case is made in two parts, the shank of the lower being inserted into the round end of the horseshoe magnet and securely drawn into place by means of a locknut and powerful spanner. The upper half of the transmitter case is secured to the lower half by means of a finely cut thread, doing away entirely with holding screws. The cord connections for the transmitter and the pinions holding the damping springs in place are all attached to a metal disc, the arms of which are arranged in tripod fashion, which screws into the upper half of the transmitter case. The transmitter has a carbon cup so mounted as to vibrate freely with the motion of the diaphragm, keeping the granular carbon in an active condition and preventing packing. The mouthpiece of the transmitter is attached



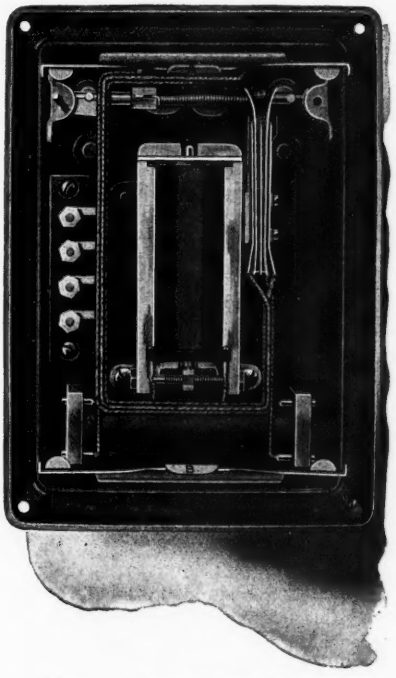
Receiver Parts and Sectional View of Hand Telephone.

to a threaded metal nipple, which, in turn, is fastened to the upper half of the transmitter case by means of a thin brass friction disc. This maintains the mouthpiece with relation to the transmitter case, and at the same time allows the mouthpiece to take any position to suit the convenience of the speaker.



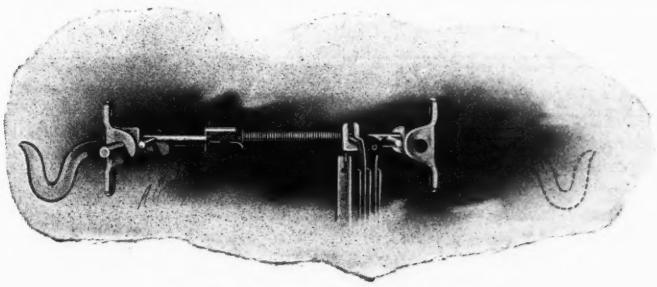
Showing Telephone Instrument and Transmitter Parts.

The compact bell box used with this instrument is made of cold pressed steel and contains the switches, condenser, induction coil, ringer movement and cord terminal block. A single-coil ringer has been developed which makes possible a considerable reduction in the size and weight of the bell box. The coil is placed between the arms of the permanent magnet, the coil and magnet being held securely to the bell box by means of metal yokes and distance-pieces. The coil is built up upon a split brass tube, through which the shank of the bell-tapper passes. This shank terminates in a steel spring which is supported upon a threaded adjustment screw and held firmly in place by means of locknuts. With this single-coil ringer the armature of the bell is susceptible to a wide range of frequencies, and requires no adjustment. Another valuable feature in connection with the bell box is the method by which the bells may be finally adjusted without taking down the bell box, and by simply using an ordinary screw-driver. In adjusting the bells the operator is requested to give a long ring, and while the one bell is held firmly, the other is adjusted positively by turning a screw on the outside of the box either to the right or to the left. When one bell is adjusted the other is manipulated in the same way, positive adjustment being arrived at in a very short time.



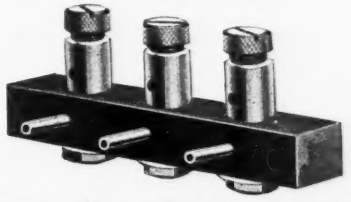
Interior View of Bell Box.

The switch hook with this instrument is interchangeable and may be used on either side of the box without any disarrangement of the switches. The Wire and Telephone Company of America also supplies a hook switch which can be mounted on desk or wall independent of bell box, permitting the "Easophone" to be placed wherever most convenient without regard to location of the bell box. A spring tension on the rocker arm of the hook switch is provided by a long helical piano-wire spring. The tension on this spring may be regulated by means of a dowel set in the rocker arm and an adjustment nut which has four cross-cuts in its opposite faces. The induction coil is placed in the bottom of the bell box and is held in place by metal yokes. Both the induction coil and the ringer movement may be easily removed for inspection or repair. The switch hook springs are of the long, parallel type, and contact is made by means of a rolling motion transmitted from the switch hook through a rocker arm.



Adjustable Switch Hook and Switches.

The condenser forms the back cover of the bell box, and is held in place by heavy brass spring clamps. The bell-box terminal block is located inside the box, and the cord terminal block is fastened to the top of the box. The cord terminal block is equipped with Houghton binding posts. In making the connections from the bell box to the binding posts in the cord terminal block very thin tubes are let through the top of the box through the terminal block and into the binding posts, effectually preventing them from turning. Through these tubes the bell-box connections are made to the binding posts. The construction of the Houghton binding post affords a radical departure in the method of making the connection and contact. The interior of the post is provided with a conical seat, while the lower end of the screw is made cone-shaped, its dimensions corresponding to those of the conical seat. When the screw is turned down upon the connector the wire is rolled and flattened between the two mechanical surfaces. Owing to the shape of the screw and post, although the wire is flattened it will not be cut; consequently there is a broad point of contact and creeping is obviated because of the friction between the conical surfaces.



Method of Making Bell Box Connections to Terminal Block.

The Wire and Telephone Company of America has an experienced engineering organization and as telephone contracting engineer is in position to install complete apparatus for intercommunicating systems for houses, office buildings, hotels, etc., in addition to apparatus for local and long-distance central energy systems.

Current Electrical News

DOMESTIC AND EXPORT.

TO MERGE POWER COMPANIES—Rhodes, Sinkler & Butcher, bankers, of Philadelphia, associated with capitalists of that city, are backing a consolidation of fourteen electric power, traction and light companies in Oregon, Washington and Idaho. The valuation is placed at $6,000,000. Isaac W. Anderson, of Spokane, Wash., is at the head of the concern, the manager being A. L. Welch, of Portland.

MINE TO INSTALL ELECTRIC LOCOMOTIVES—The Boston & Montana company, of Butte, Mont., has contracted for five electric locomotives and a complete underground haulage system. The engines will cost about $2,000 each and are to be delivered in ninety days. They will be of the Baldwin pattern with Westinghouse equipment. The installation of these engines and proper electrical appliances to operate them will do away with the present system of tramming. When the Boston & Montana began operations men were employed to do the tramming, but eventually horses were substituted and are now in use.

HUDSON & MANHATTAN RAILROAD COMPANY MORTGAGE—The state railroad commission has granted the application of the Hudson & Manhattan Railroad Company, which is building the McAdoo tunnels, for consent to the issuance of a refunding mortgage for $100,000,000. The mortgage is to cover bonds to be issued for the same amount, of which $43,000,000 will be held in reserve for the future development of the company, and the remaining $57,000,000 will be used to take up outstanding five and six per cent obligations of constituent companies. The bonds will bear four and one-half per cent interest.

ELECTRIC ROAD SOLD—The Toledo & Western Electric Road, which runs from Toledo to Adrian, Ohio, and from Toledo to Pioneer, Ohio, has been sold to J. R. McNutt, of Cleveland, who headed the syndicate which some time ago endeavored to buy up the stock of the road. Mr. McNutt purchased the road for its floating indebtedness, which is approximtely $400,000. It is stated, however, that the purchaser must assume three mortgages, one of $1,250,000, covering the line between Toledo and Adrian; one of $250,000, covering the extension from Fayette to Pioneer, Ohio, which are underlying mortgages, and a consolidated mortgage of $2,500,000. This latter mortgage is for the purpose of refunding the underlying securities.

NEW OKLAHOMA ELECTRIC ROAD—A charter has been granted to the Oklahoma Railway Company, with $5,000,000 capital, and with headquarters at Oklahoma City, Pittsburg, Pa., and New York city, for purpose of building an electric interurban line as follows: West from Shawnee to El Reno and Fort Reno, with a line from Shawnee to Tecumseh; from Guthrie south to Purcell, and from Yukon southwest to Chickasha, a total of 170 miles. The line is to be built at an estimated cost of $8,000,000, traversing the counties of Pottawatomie, Lincoln, Logan, Oklahoma, Cleveland and Canadian and the Chickasaw Nation. The incorporators are: Frank Wells, O. R. Rittenhouse, G. G. Barnes, J. J. Johnson, Carlos Combs, Fred S. Combs and Edward L. Lawson, all of Oklahoma City.

ELECTRIC TRAINS ON THE NEW YORK CENTRAL—Sixteen electric passenger trains, eight each way, were run over the New York Central tracks between Grand Central Station and Yonkers on December 11. Between Grand Central Station and Highbridge they were operated by electricity. Above Highbridge the electric trains were hauled by steam locomotives. The trains were composed of from three to five cars, and left the New York city end of the line from the new and temporary suburban-traffic station beneath the Grand Central Palace at Forty-third street and Lexington avenue. The service will be continued regularly and gradually extended to other lines of the service, with an extension of the electric zone above Highbridge. As quickly as safety of operation will justify it, the New York Central officials assert, the number of electric trains and the length of their runs under their own power will be increased.

GREAT WESTERN POWER COMPANY—The Great Western Power Company, of California, has filed a mortgage to the Central Trust Company, of New York, as trustee, to secure an issue of $25,000,000 five per cent gold bonds, dated July 1, 1906, and due July 1, 1946, but subject to redemption after five years at 106 and interest. Of this issue, $8,500,000 is outstanding. This company was recently incorporated under the laws of California with an authorized capital of $25,000,000 as the operating company for the Western Power Company of New Jersey. The latter is a holding company with $18,000,000 authorized capital stock, of which $6,000,000 is six per cent preferred, cumulative after five years. It is expected that all the stock will be soon issued. Edwin Hawley is president of the company. The Great Western Power Company expects to furnish power, light and heat to all the towns in northern and central California.

SYRACUSE LIGHTING COMPANY LEASED—At a meeting of the stockholders of the Syracuse (N. Y.) Lighting Company, on December 6, it was voted to increase the capital stock from $3,000,000 to $8,000,000 and to lease the plant and business to the recently formed Onondaga Lighting Company. While the vote was practically unanimous, the new stock can not be issued nor the lease executed until an injunction granted by Supreme Court Justice W. M. Rogers is disposed of. This injunction was secured by former Mayor J. B. Kline, acting as attorney for James M. Bissell, of Hartford, Ct. The representatives of the company asked the privilege of holding the stockholders' meeting as had been arranged, inasmuch as stockholders from out of the city were in Syracuse, and the attorneys agreed to abide by the injunction and not to execute any of the changes upon which the stockholders should agree without due process of disposing of the injunction. With this understanding the meeting was held. The injunction which was granted was served upon Mr. Cummins after the meeting had been held. Before executing the lease and issuing the stock the company will have to make a motion in court to dissolve the injunction. This will probably be done at the time the state commission of gas and electricity has a hearing at Albany in relation to the new Onondaga company. The proposed action of the stockholders must meet the approval of that commission before it becomes legal.

BONUS OFFERED CONSENTING STOCKHOLDERS OF ELECTRIC COMPANY OF AMERICA—Notification of the right to subscribe to the $3,500,000 preferred stock in the proposed American Gas and Electric Company, which the Electric Bond and Share Company is planning to organize as a holding corporation for the Electric Company of America, has been made to shareholders in the Electric Company of America. This purchase right is limited to stockholders in the Electric Company of America who have consented to the consolidation. The right carries with it a bonus of common stock in the American Gas and Electric Company. The first step in the contemplated merger of the Electric Company of America in the American Gas and Electric Company will be taken by the Electric Bond and Share Company, which is planning to secure control of the Electric Company of America by exchanging its collateral trust five per cent gold bonds for the stock of the Electric Company of America. Later, the Electric Bond and Share Company will incorporate the American Gas and Electric Company, which will control and operate the business of the Electric Company of America, and probably that of other electric light and traction companies in New Jersey, Pennsylvania, Ohio, West Virginia and Colorado. This parent company will be capitalized with $3,500,000

in preferred six per cent and $3,500,000 in common stcok, as well as with $6,282,000 in collateral trust five per cent bonds. It is believed this announcement that the shareholders in the Electric Company of America will have the privilege of taking preferred stock in the new company will create a much better feeling toward the proposed deal.

MICHIGAN POWER COMPANY FORMED—The Tittabawassee Power Company, capitalized at $1,000,000, has filed articles of incorporation in Midland county, Mich. The incorporators are: George G. Prentis, Theodore H. Hinchman, Jr., Lewis E. Flanders, Benjamin F. Mulford, L. M. White and William C. Manchester, of Detroit, Mich., and Louis E. Rowley, of Lansing, Mich. The company is organized for the purpose of building dams and utilizing the power of the water for the Tittabawassee river at Edenville.

SUIT BROUGHT TO DECLARE ILLEGAL THE FORMATION OF THE METROPOLITAN SECURITIES COMPANY—A suit of similar nature to the Northern Securities merger action has been begun in the United States Circuit Court by D. W. Burrows, of Chicago, to have declared illegal the formation of the Metropolitan Securities Company, into which were merged the Belmont-Ryan traction interests in New York city. The defendants are the Interborough-Metropolitan Company, the Interborough Rapid Transit Company, the Metropolitan Street Railway Company, the Metropolitan Securities Company, the Manhattan Railway Company, the New York City Railway Company, Thomas F. Ryan, August Belmont, Cornelius Vanderbilt, Edward J. Berwind, John D. Crimmins, Andrew Freedman, Thomas P. Fowler, Gardiner M. Lane, F. S. Gannon, R. W. Meade, Oren Root, Jr., Edward W. Sayre, H. H. Vreeland and Charles E. Warren. In his complaint Mr. Burrows alleges that the merger of the traction interests is tantamount to a conspiracy in restraint of trade, and as a holder of 1,400 shares of stock in the Metropolitan Securities Company he asks that the combination be dissolved. He asks, also, that the old stockholders have restored to them their stock, which he alleges the defendants have taken under their ownership. Besides a violation of the stock corporation laws of New York state, which prevent a domestic corporation from combining for the creation of a monopoly, the complainant alleges a violation of Section 168 of the Penal Code, which makes it a misdemeanor to conspire in constraint of trade.

ELECTRICAL SECURITIES.

While the market was unsettled and irregular, with a sharp break in the middle of the week, the general tendency was toward improvement, and nearly all the more important industrials either made slight gains or held to the prices quoted a week ago. There is a very evident disposition on the part of big interests to make every effort to hold up prices until after the turn of the year, in order, likely, with an easing in money rates, to create a bull market and influence animation in public participations. For eleven months of the year, both imports and exports made a new high record for the period. Total imports were $1,186,036,125, against $1,078,011,751, while exports were $1,607,693,550, against $1,427,252,275. The excess of exports in this period was $421,657,430, against $349,250,524 last year. November gold movements resulted in an excess of imports of $6,971,201, against $4,065,472. For the eleven months there was an excess of gold imports of $103,130,624, against $2,138,589 last year.

ELECTRICAL SECURITIES FOR THE WEEK ENDING DECEMBER 15.

New York:	*Closing.*
Allis-Chalmers common	16¾
Allis-Chalmers preferred	44⅛
Brooklyn Rapid Transit	81⅞
Consolidated Gas	138
General Electric	160
Interborough-Metropolitan common	36¼
Interborough-Metropolitan preferred	73½
Kings County Electric	150
Mackay Companies (Postal Telegraph and Cables) common	72½
Mackay Companies (Postal Telegraph and Cables) preferred	68½
Manhattan Elevated	141½
Metropolitan Street Railway	106
New York & New Jersey Telephone	126
Western Union	85¾
Westinghouse Manufacturing Company	150

The newly elected directors of the Metropolitan Street Railway Company organized by the reelection of all retiring officers.

The Kings County Electric Light and Power Company will issue $1,800,000 more capital stock, bringing the total up to the $10,000,000 authorized in 1905. Stockholders will have the right to subscribe for the new shares at par value in the proportion of nine for every forty-one shares held until 3 P. M., February 1, 1907.

The Brooklyn Rapid Transit Company has placed an order with the Westinghouse Machine Company for the largest stationary steam-power machines ever constructed. The contract amounts to $2,500,000, and calls for five steam turbines of a capacity of 25,000 horse-power each. The Westinghouse Electric and Manufacturing Company will construct five electric power generators of the same capacity as the steam turbines.

The Western Union Telegraph Company has issued its preliminary quarterly report (partly estimated) for the quarter ended December 31, 1906. This shows as follows: net revenue, $1,600,000; bond interest, $332,687; balance, $1,267,313; dividends, $1,217,023, leaving a surplus of $50,290, which added to the previous surplus of $16,959,536, makes a total of $17,009,826. The actual returns for the quarter ended September 30 were: net revenue, $1,660,519; bond interest, $332,687; balance, $1,327,832; dividends, $1,217,024; surplus, $110,809; previous surplus, $16,848,728; total surplus, $16,959,537. The directors of the Western Union Telegraph Company have declared the regular quarterly dividend of 1¼ per cent, payable January 15 to stockholders of record December 24. Books close December 24 and reopen January 2.

Boston:	*Closing.*
American Telephone and Telegraph	136¾
Edison Electric Illuminating	226
Massachusetts Electric	69
New England Telephone	129
Western Telephone and Telegraph preferred	80

The Massachusetts Electric Companies issues its seventh annual report, covering the year ended September 30, 1906. The consolidated income account from operation of the controlled companies shows as follows: gross earnings, $7,518,240; expenses, $4,883,552; net earnings, $2,634,688; charges, $1,594,503; balance, $1,040,185; dividends, $710,406; surplus, $329,779. The amount spent for maintenance was increased by $210,583 over the expenditure of the previous year, and 6 per cent of the gross receipts, instead of 5 per cent as heretofore, an increase of $70,638, was credited to reserve for accidents. Eleven miles of track have been built, forty-seven miles rebuilt, thirty-five new cars, eight plows, etc., purchased and fifteen miles of new wire strung. The depreciation found by the railroad commissioners amounted to $185,370, which was charged off to profit and loss.

Philadelphia:	*Closing.*
Electric Company of America	11⅝
Electric Storage Battery common	69
Electric Storage Battery preferred	69
Philadelphia Electric	8½
Philadelphia Rapid Transit	25½
United Gas Improvement	95⅞

The directors of the United Gas Improvement Company have declared the regular quarterly dividend of 2 per cent, payable January 15 to stock of record December 31.

It is reported that the new financial plan of the Philadelphia Rapid Transit Company has been completed and calls for an issue of $25,000,000 new stock.

At the stockholders' meeting of the Electric Company of America, President Snowden announced that the surplus on hand at the close of the last fiscal year had been expended and that more money had been borrowed for the company's use. Stockholders ratified the agreement made by the directors to sell the property to the Electric Bond and Share Company under conditions heretofore printed. The vote was over 80 per cent in favor of ratifying the plan.

Chicago:	*Closing.*
Chicago Telephone	115
Chicago Edison Light	144
Metropolitan Elevated preferred	72
National Carbon common	86½
National Carbon preferred	116
Union Traction common	—
Union Traction preferred	—

ELECTRIC RAILWAYS.

OSKALOOSA, IOWA—The Oskaloosa & Buxton Interurban Company has purchased the Oskaloosa Traction and Light Company's plant for $95,000.

EAST ST. LOUIS, ILL.—At a meeting of the East St. Louis city council the McKinley electric railway system was granted a franchise to operate over certain streets inside the city limits.

CHATTANOOGA, TENN.—Contracts have been awarded the West Construction Company by the Chattanooga Railways Company for remodeling and making an addition to the company's power plant at Ridgedale. The contract price is $10,000.

ALBANY, N. Y.—The Buffalo & Lake Erie Traction Company, of Buffalo, a consolidation of the Buffalo & Lake Erie Traction Company and the Dunkirk & Fredonia Railroad Company, has been incorporated. The capital stock is $4,070,000.

MINNEAPOLIS, MINN.—The Robinsdale suburban trolley line has been purchased by the Twin City Rapid Transit Company. This disposes of the last independent line in or about Minneapolis and St. Paul and gives the Twin City entire control.

RENO, CAL.—Senator Francis G. Newlands and Senator George S. Nixon, for the recently organized Reno Development Company, have completed the purchase of the Fleishhacker electric line running from Reno to Sparks, about three miles long. The deal was consummated for the sum of $200,000.

DENVER, COL.—The Colorado & Southern Railroad Company has signed a contract with the Northern Colorado Power Company for electric power to be furnished the railroad for a trolley system between Denver and Boulder as soon as the plant of the power company at Lafayette can be completed.

ATLANTA, GA.—The new owners of the Rome, Ga., traction system are planning to extend the line to Rockmart, in Polk county, a distance of twenty-five miles, connecting with the Seaboard Air Line. The system was recently purchased by a syndicate composed of Louisville, Ky., capitalists, headed by S. S. Busch.

ALAMEDA, CAL.—The city trustees at a special meeting granted F. M. Greenwood an extension of four months in which to deposit with the city treasurer $50,000 cash to guarantee that he will carry out the terms of the franchise granted him some time ago to construct an electric line on Clement avenue, to connect with a projected ferry line to San Francisco.

HARTFORD, WIS.—Surveyors of the Milwaukee Electric Railway and Light Company are laying out the route of an electric line from North Milwaukee to Fox Lake, *via* Holy Hill. It is said that persons anxious to secure trolley service between the points named will donate a right of way in order to expedite the building of the line. Menomonee Falls, Lake Five and Beaver Dam will be touched by the proposed extension.

SALT LAKE CITY, UTAH—More than $3,000,000 will be spent by the Utah Light and Railway Company in the improvement of its street railway, electric lighting and power system in Salt Lake, as rapidly as the work can be done. All franchises held by the company will be fully exercised. In addition to the lines now being operated, the company proposes to run interurban lines to Garfield, North Salt Lake, Sandy and Big Cottonwood.

WATERLOO, IOWA—Articles of incorporation of the Empire Railway Construction Company, capital $250,000, have been filed with the county auditor. This is the building company which is to construct the proposed Chicago, Iowa & Northwestern Railroad, which is to build a line from Anamosa to Austin, Minn., to connect there with the line which the company expects to build into northwestern Minnesota, the route of which has not been definitely selected as yet.

LOUISVILLE, KY.—A corps of surveyors has started work on a survey for an interurban line which the Louisville, New Albany & Corydon Railroad Company proposes to build between New Albany and Corydon. The company operates a steam railroad between Corydon and Corydon Junction, a distance of seven miles, connection being made with the Southern Railway at the junction, and at a meeting of the stockholders held at Corydon the officers were authorized to extend the line to New Albany by way of Lanesville and equip it with electric cars.

STANDISH, MICH.—A deed of trust given by the Grand Rapids Electric Railroad Company, J. W. Boynton, president, has been filed at the register of deeds' office in Gladwin, running to the Cleveland Trust Company, to secure $250,000 for the purpose of constructing an electric railroad from Grand Rapids to Alpena through Gladwin, Standish, West Branch, Tawas, Rose City and other points, also from Grand Haven to points in Ohio. Similar deeds will be recorded in each county through which the road passes.

DETROIT, MICH.—Work on the new electric railroad which is to connect Detroit with Jackson, *via* Dearborn and the River Rouge, has begun near Dearborn and just beyond River Rouge. The road will be a continuation of the Boland line already completed from Jackson to Chelsea and from Jackson to Battle Creek. The president of the company which has charge of the work is C. A. Osborne, of New York city; the secretary, George Meecham, of Jackson, Mich.; N. F. Potter and W. A. Boland, of Jackson, are also identified with it.

KALAMAZOO, MICH.—W. H. Patterson, promoter and one of the directors of the Grand Rapids & Kalamazoo Valley Electric Railroad Company, has received a telegram announcing the sale of the bonds for the building of the road connecting this city with Grand Rapids. He refuses to make known the names of the purchasers, but says that they are people living in New York and Philadelphia, and none of them is interested in any western electric road. The contract was also let for building the road. It requires that work begin March 1 and be completed within a year.

NEW ORLEANS, LA.—Negotiations for the purchase of the Baton Rouge Electric Light and Street Railway Company have been concluded, the financial interests behind Mr. Gottlieb, a Baton Rouge banker, having acquired the property. It is said that capital stock to the amount of $1,000,000 will be issued and that the property will be vastly improved. A new system of lights and street cars will be put in operation as soon as the material can be put on the ground. Bonds will be issued and a Boston firm will underwrite them. It is believed that the same financial backing is behind the proposed New Orleans and Baton Rouge electric road.

HARTFORD, CT.—Engineers have been making preliminary surveys for an important trolley line which the Shore Line Electric Railway Company has a franchise to construct. The corporation, which has an authorized capital stock of $1,000,000, is empowered to build and operate an electric road along the Connecticut shore through the towns of Bradford, Guilford, Madison, Clinton, Westbrook, and Saybrook to the village of Ivoryton in the town of Essex. At Branford the line will connect with a New Haven branch of the Connecticut Railway and Lighting Company's system. The route is through a succession of thrifty towns which are now isolated from trolley communication. It is expected that the section of the road from Branford to Saybrook will be constructed at an early date.

DENVER, COL.—The projectors of a new electric railroad into Denver, running from Platte canon into Englewood and to be known as the Denver & Southeastern, have elected their first board of directors and officers. Behind the scheme for the new road are the owners of the Platte Canon Fuel and Power Company. They announce that they have already completed the grading for their line for four miles down the canon, leaving the sixteen miles between there and the northern terminus at Englewood still to be completed. Plans for a large power-house to be erected at the mines of the company in Platte canon are nearly completed. It is intended to carry both coal and passengers between Platte canon and Denver and ultimately to extend the line up the canon if found desirable. The officers selected are: George I. Cole, president; C. H. Chase, vice-president; I. C. Cockey, secretary; S. B. Thomas, treasurer. All of the officials but Secretary Cockey are said to be residents of Clarke county, South Dakota, and will move to Denver. It is planned to install standard-gauge tracks and very heavy cars for freight and passenger service. The company is at present operating coal mines in the Platte canon and is preparing to enlarge these mines immediately.

ELECTRIC LIGHTING.

LOUISVILLE, KY.—The Louisville Lighting Company has purchased a $75,000 turbine, which will double its capacity.

SOUTH HADLEY FALLS, MASS.—The South Hadley Falls Electric Light Company will install a 650-horse-power engine and a 2,000-light dynamo.

BOSTON, MASS.—The gas commissioners have granted the Attleboro Gas and Electric Company the privilege of issuing 115 new shares at $225.

WYMORE, NEB.—The Wabash electric light plant, which was recently given into the hands of a receiver, has been leased to L. E. Watson, of Beatrice.

NATCHEZ, MISS.—On March 17, 1907, the city of Natchez will open bids for furnishing not less than 115 2,000-candle-power arc lights, all-night schedule, on a five or ten-year contract.

PALESTINE, TEX.—Contracts have been let for a new electric light plant to replace the old one which has been outgrown by the town. The machinery will all be in duplicate to avoid breakdowns.

HENNESSEY, OKLA.—Hennessey has granted a franchise to the Hennessey Electric Light and Power Company. The city has the option at the end of ten years of buying the proposed plant at the appraised commercial value.

MENOMINEE, MICH.—Oshkosh, Green Bay and Chicago capitalists have organized a $600,000 corporation to build a large power-house on the Menominee river and transmit the power to Menominee and Marinette for industrial purposes.

MARQUETTE, MICH.—The Stephenson village council has granted to T. F. Goulder, of Ingalls, a thirty-year franchise for establishing an electric light plant. Mr. Goulder intends to put in a plant large enough to supply the needs of the village for years to come.

MANCHESTER, CT.—The power for the lighting of Manchester will soon be furnished by the Hartford Electric Light Company and already plans are under way for the change. The material necessary has been ordered and it is expected that the change will go into effect January 1.

LITTLE FALLS, N. Y.—I. N. Lovenheim, owner and manager of the Consumers' Electric Light Company, announces the discontinuance of business. The lighting contracts now in force have been taken over by the Herkimer County Light and Power Company and fulfilled by that concern.

ROSEBURG, ORE.—It is announced that the Willamette Valley Company has purchased the local water and light plants from G. G. Majors and will take charge immediately. The price paid Mr. Majors above the bonded indebtedness of $20,000 is announced as $30,000. The present plants are to be improved.

NEW YORK, N. Y.—The New York Edison Company, it is stated, will erect a five-story fireproof power-house on a plot on the north side of Sixty-fourth street, east of Third avenue. Plans are being prepared by the company's architect, who is designing a structure similar to the other power-houses in the metropolitan district.

BOSTON, MASS.—The gas and electric light commissioners have issued an order authorizing the Pittsfield Electric Company to issue bonds to the amount of $50,000 and stock to the amount of $75,000, the proceeds to be applied on the payment of debts incurred for the Silver Lake station and for other improvements and additions to its plant.

MILWAUKEE, WIS.—Articles of incorporation have been filed at Madison by the Plankinton Light and Power Company. The incorporators are: H. A. J. Upham, William Woods Plankinton and George P. Miller. Mr. Plankinton, who is president of the new corporation, has made application for a franchise for laying conduits and stringing wires in the Fourth ward.

SUPERIOR, WIS.—At a meeting of a committee from the city council and the directors of the Superior Water, Light and Power Company, the directors expressed a willingness to sell to the city the present light plant. No definite arrangements have been made, but the city will look up the matter of arranging to pay for the plant and the directors will consult with the bondholders of the company. A definite agreement is expected by February 1.

MIDDLETOWN, N. Y.—Four farmers in Stamford township, Delaware county, are considering the project of building a small electric light plant. Foote Hollow is the name of a branch valley of the township, and through it runs a stream across which they propose to place a dam as a source of power. The plant will be in the building of James Stowe and controlled by him. The other three farmers are: O. P. Canfield, W. P. Mervin and Nicholas Thiem.

FERGUS FALLS, MINN.—The city council has authorized the electric light commission to have plans prepared for the construction of a new dam to furnish power for the city electric light plant. The commission, in outlining its future policy, announces that as soon as the dam is constructed, the rate for electric lights in Fergus Falls will be reduced from ten cents to five cents per kilowatt-hour. The present rate has not only taken care of extensions and bonds, but has permitted the accumulation of a surplus of about $19,000.

CANASTOTA, N. Y.—The village board has awarded a contract and granted a franchise to the Central New York Power Company (Trenton Falls power) for lighting the village for a term of five years. Fifty arc lamps, to burn from half an hour after sunset until 1 A. M., except on moonlight nights, will be furnished at $35 a year apiece. There will be five all-night arc lights at $55 each. Quite a number of incandescent lights also are to be furnished, and the total annual expense will be $3,146. The company also agrees to install a plant to furnish gas for heating and illuminating purposes.

ST. LOUIS, MO.—Thomas H. Carter, supervisor of city lighting, has submitted a report to the board of public improvements regarding the expense of a municipal lighting system. According to the figures, it would cost the city $2,523,200 to erect such a plant and $512,980 a year to run it. Last year the lighting service, under contract, cost $548,939.25. This would mean a saving to the city of $35,959.25 a year. Supervisor Carter's report embraces a system that would supply 6,000 480-watt arc lamps for street lighting; 500 thirty-candle-power incandescent lamps for alleys and parks, and about 15,000 sixteen-candle-power incandescent lamps for public buildings. The city at present is using 1,053 arc lamps, 772 incandescent lamps and 17,079 mantle lamps. The municipal plant, according to the figures prepared, would furnish light to many streets not now lighted, and would do away altogether with the gas lamps now used through the greater portion of the city. The report is based on the use of an arc lamp at every street intersection, and with no distance between arc lamps to exceed 400 feet. The municipal lighting system would comprise a main power station to cost $802,500, and three substations to cost $25,000 each. Supervisor Carter figures that it will cost $69.73 a year for each arc lamp under the municipal system. At present the lamps cost $98 a year. The incandescent lamps he estimates will cost $17.20 a year, while under the present contract they cost $19.

OBITUARY NOTE.

FITZHUGH TOWNSEND, A.B., E.E., instructor in electrical engineering at Columbia University, died of typhoid fever on December 11, 1906, at the age of thirty-four years. Mr. Townsend graduated from the academic department of Columbia University in 1893, and later pursued the course of electrical engineering, graduating in 1896. He has been connected with the electrical engineering department of Columbia University as assistant, tutor and instructor since 1897, having been engaged in practical work for one year after graduation. He also spent several summer vacations at the works of the General Electric and Westinghouse companies, and has practiced as consulting engineer and expert in electrical work. For the past four years, he has been particularly interested in the development of a new railway-signaling system, involving many ingenious features devised and perfected by him. This system has been successful and is now being applied on several large railroads. Mr. Townsend was joint author with Professor George F. Sever of a work on "Laboratory and Factory Tests in Electrical Engineering." Mr. Townsend held for a number of years the amateur fencing championship of the United States. He was a member of the Union Club and an associate member of the American Institute of Electrical Engineers.

DATES AHEAD.

Electrical Trades Exposition. Chicago, Ill., January 14-26, 1907.

Northwestern Electrical Association. Milwaukee, Wis., January 16, 1907.

Ohio Engineering Society. Columbus, Ohio, January 22-24, 1907.

Jamestown Ter-Centennial Exposition. Norfolk, Va., April 26 to November 30, 1907.

PERSONAL MENTION.

PROFESSOR J. J. THOMSON, who occupies the chair of experimental physics at Cambridge University, England, has been awarded the Nobel prize for physics, amounting to £7,500.

MR. J. B. HAWLEY, formerly with Bruce & Johnston, has opened an office at 5 East Forty-second street, where he is handling the advertising and publicity accounts of technical concerns of this city.

M. HENRI MOISSON, of Paris, has been awarded the £7,500 Nobel prize for chemistry. His earliest work of importance was the isolation of the element fluorine, twenty years ago. An anniversary medal is shortly to be presented to him.

MR. CHARLES W. CHAMBERLAIN, of Concord, N. H., has been made chief inspector of the Holyoke (Mass.) exchange of the New England Telephone and Telegraph Company. Mr. Chamberlain has been connected with the company for the past eight years.

MR. A. L. LINDNER, manager of the Citizens' Street Railway and Light Company, of Muscatine, Iowa, has resigned, his resignation to take effect January 1, 1907. Mr. Lindner states that he is not ready to disclose his plans, but that he will ally himself with a local industry.

MR. JOHN F. MADDEN is to succeed F. L. Fullam as superintendent of the Clinton (Mass.) Gas Light Company when Mr. Fullam takes up his new duties as general manager of the Clinton Gas Light Company and the Leominster (Mass.) Electric Light and Power Company.

MR. B. F. STANTON, of San Jose, Cal., has been appointed superintendent of the local system of the Santa Clara Interurban Railroad Company at Hanchett, Cal., succeeding C. C. Benson, who has been made manager of the entire system, with headquarters at San Jose. Mr. Benson succeeds Richard Emory, who died recently.

MR. C. LOOMIS ALLEN has been appointed general manager of the Syracuse (N. Y.) Rapid Transit Railway Company and of the other electric lines controlled by the Vanderbilt interests. Mr. Allen's jurisdiction will extend over the cities of Syracuse, Utica, Rome and Oneida, and, in addition, the proposed electrified section of the West Shore Railroad's interurban system.

MR. G. J. A. PAUL, Youngstown, Ohio, superintendent of the Sharon & Youngstown, Sharon & New Castle and local traction lines, has been appointed general superintendent of all lines owned by the Mahoning & Shenango Valley Traction Company in Sharon, Youngstown, New Castle, Niles, Warren and South Sharon. He is the first general superintendent the company has had since these lines were merged.

MR. J. B. INGERSOLL, assistant manager and chief electrical engineer of the Spokane & Inland Railway, Spokane, Wash., has also been made general manager and chief electrical engineer of the Inland Empire system. Mr. Ingersoll succeeds Mr. F. A. Blackwell, who resigns to devote more time to other interests. Mr. Blackwell will, however, continue as chairman of the board of directors of the Inland Empire system.

MR. H. C. MEISEL has severed his connection with the Western Electric Company and is preparing to enter the electrical supply and construction business, with a view of handling electrical apparatus in the Southwest. In traveling over western Texas and New Mexico Mr. Meisel has been impressed with the opportunity presented for an electrical-supply business. His headquarters for the present will be at Amarillo, Tex., which town he believes is destined to become a growing distributing centre for western Texas and New Mexico. The business of this section is being handled from Kansas City, Fort Worth and Dallas, which are from 350 to 500 miles distant.

MR. FRANK H. TAYLOR has been elected a director and a vice-president of the Yale & Towne Manufacturing Company by the stockholders of the company. Mr. Taylor was born in Cincinnati, Ohio, and after leaving school entered Haverford College, near Philadelphia, from which he was graduated after a four-year course. He immediately entered Harvard University, from which he was graduated in 1877 with the degree of A.B. Leaving college, Mr. Taylor entered the employ of the George Fox Starch Company, Cincinnati, Ohio, as an apprentice. He advanced through various positions to the post of superintendent, and in 1882 moved to Philadelphia, where he became one of the organizers and treasurer of the Belmont Iron Company, later becoming its president. In 1890 Mr. Taylor accepted the position of manager of the Philadelphia branch house of the Yale & Towne Manufacturing Company. He retained this position for the following seven years. In 1897 he transferred his residence to Pittsburg, Pa., to accept an appointment as sales manager of the Westinghouse Electric and Manufacturing Company. He served three years in this position, and was then promoted to the position of fourth vice-president, serving as such for about three years, being finally elected to the position of second vice-president, which he filled for the following three years or until he resigned in April, 1906. He is a director of the Westinghouse Electric and Manufacturing Company and of the Provident Life and Trust Company, Philadelphia, and a trustee of the Engineers' Club, of New York. As a vice-president of the Yale & Towne Manufacturing Company, Mr. Taylor's duties will relate equally to the manufacturing and commercial sides of the business, and ultimately will include many of the matters which heretofore have been attended to by the president. The present official organization of the Yale & Towne Manufacturing Company is as follows: president, Henry R. Towne; vice-presidents, Schuyler Merritt, Frank H. Taylor; secretary, J. H. Towne; treasurer, A. R. Erskine; general manager, Kirk Brown; general superintendent, Walter C. Allen.

MR. FRANK H. TAYLOR.

NEW PUBLICATIONS.

PROCEEDINGS OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION—The proceedings of the National Electric Light Association for the convention at Atlantic City, N. J., June 5, 6, 7 and 8, 1906, have been issued in the usual handsome style, made up in three volumes. The first volume includes the routine business of the convention, a list of the five classes of members, lists of the officers and executive committee, the committee reports and complete copies of the papers and discussion. Vol. ii is devoted to the question box, edited by Paul Lüpke. Vol. iii, which is for distribution to class A members, contains reports of the executive sessions. The frontispiece of vol. i is a handsome reproduction of a photograph of William H. Blood, Jr.

PROCEEDINGS OF THE NATIONAL-INTERSTATE TELEPHONE ASSOCIATION—The proceedings of the convention of the National-Interstate Telephone Association, held at Chicago, Ill., June 26, 27 and 28, have been published and issued in book form by the International Independent Telephone Association of America, the new name of the National-Interstate association. This book contains a detailed record of the daily convention proceedings, the papers and reports of committees, including standard forms of accounting, with a full account of the banquet held at the White City on the evening of June 27. There is also a complete list of officers and committees, the names of all those attending the convention, a summary of important data according to states, with considerable other data of value to all interested in the independent telephone movement.

EDUCATIONAL NOTE.

REGISTER OF CORNELL UNIVERSITY—Cornell University, Ithaca, N. Y., has issued the register for the year 1905-1906. It contains the usual descriptions of courses offered at the various colleges and a catalogue of students.

INDUSTRIAL ITEMS.

THE ELECTRIC CONTROLLER AND SUPPLY COMPANY, Cleveland, Ohio, is mailing to some of its friends a beautiful souvenir photo.

JOHN L. GLEASON, Jamaica Plain, Mass., patentee and manufacturer of "Fancleve" molding and conduit boxes, is distributing a very attractive calendar for 1907.

THE MANHATTAN ELECTRICAL SUPPLY COMPANY, New York city, is calling attention to its Christmas tree outfits for both incandescent lighting and dry-battery circuits. The literature on this subject will be sent to any one interested upon request.

THE BECK FLAMING LAMP COMPANY, New York city, is moving its office and factory to 80 Greenwich avenue. The company will occupy a large, well-equipped factory and will be in a position to manufacture its new type of flaming-arc lamps in the near future.

THE DAYTON GLOBE IRON WORKS COMPANY, Dayton, Ohio, has ready for distribution a pamphlet descriptive and illustrative of head-gate hoists. This includes hoists operated by means of a lever inserted in a winch wheel, crank and pilot-wheel-operated hoists, and several special designs.

QUEEN & COMPANY, INCORPORATED, Philadelphia, Pa., have published a very complete catalogue and price list of thermometers, pyrometers, hydrometers, barometers and weather bureau apparatus. In addition to complete price lists and dimensions there is given a great amount of literature concerning the various instruments.

THE SPRAGUE ELECTRIC COMPANY, New York city, has issued a pamphlet entitled "The Electrical Equipment of a Modern Hotel." This describes and illustrates the equipment in the Hotel Gotham at Fifth avenue and Fifty-fifth street, New York city. The electrical equipment, including motors and generators, was furnished by the Sprague Electric Company. The company is also distributing a handsome pamphlet describing its electric hoists and cranes.

THE MOORE ELECTRICAL COMPANY, Newark, N. J., announces that the treasury department of the United States has recently contracted with it to light the entire west side of the mezzanine floor of the New York post-office with the Moore light. This installation will consist of more than a thousand feet of Moore tubing. The Moore tubes, it is announced, will not use more than twenty kilowatts per hour, and the maker states that the illuminating effect will be increased about five times. It is said that this installation will displace 525 sixteen-candle-power incandescent lamps. The opposite side of this floor is now lighted with mercury vapor tubes, so that there will be available a very interesting demonstration of the qualities of both these forms of illuminants.

NEW MANUFACTURING COMPANIES.

CLEVELAND, OHIO—The Ohio Electric Specialty Company has been incorporated by P. C. Greenwall, F. C. Hackett, Walter S. Lister, Elizabeth Lewis and L. M. Henders. The capital is $20,000.

DOVER, DEL.—The Austin-Smith Engineering Company, of Baltimore, Md., has been incorporated with a capital stock of $50,000 to manufacture, buy and sell electrical and mechanical appliances.

CAMDEN, N. J.—The Electric Store Service Company has been organized to build and install automatic carrier systems. The capital is $120,000, and the incorporators are: M. E. Sturges, Franklin A. Smith and E. R. Sutton.

PORTLAND, ME.—The Livermore Pay Station Company has been incorporated to manufacture telephone and telegraph appliances. The president is C. H. Carter, of Arlington, Mass.; treasurer and clerk, L. L. Height, of Portland, Me.

MILWAUKEE, WIS.—The Battery and Power Company, a $500,000 corporation, has been formed in Milwaukee by Frank Gregory, of Marinette, Wis.; A. H. Wegner and Charles Marnitz. The company claims to have a very cheap, powerful and durable battery.

COLUMBUS, OHIO—The Jonah Battery Company, of Toledo, has been incorporated with a capital stock of $150,000 by J. N. Bick, A. W. Bick, L. M. Fox, H. F. Bossard and Marion Bossard. The company will manufacture electric batteries, motors, dynamos, etc.

TRENTON, N. J.—The Newark Gas and Electric Fixture Company has been incorporated with a capital of $25,000, to deal in gas and electric fixtures. The incorporators are: Charles L. Beck, Charles O. Geyer and F. C. Ferguson. The registered office of the company is at East Orange, N. J.

ALBANY, N. Y.—The Mohawk Electrical Supply Company, of Utica, has been incorporated with the secretary of state, to do an electrical jobbing business. The capital stock is $25,000 in shares of $100 each. The directors are: George A. Redman, J. Frank Morse and Eleanor M. Morse, of Utica.

Record of Electrical Patents.

Week of December 11.

837,951. TELEPHONE CALL REGISTER. Joseph J. O'Connell, Chicago, Ill., assignor to Western Electric Company, Chicago, Ill. Filed July 19, 1902. Registration is effected through a traveling transmitter mechanism and a counting train.

837,994. MAGNETIC SEPARATOR. James C. Winder, East Point, Ga., assignor to E. Van Winkle Gin and Machine Works, Atlanta, Ga. Filed May 5, 1906. Three magnetic bars connected to an equal number of poles of an electromagnet are inserted in slots in a non-magnetic cable.

838,005. ELECTRICAL CIRCUIT INTERRUPTER. Albert M. Bullard and William H. Matthies, New York, N. Y., assignors to Western Electric Company, Chicago, Ill. Filed September 9, 1905. Two relays, each of which in opening resets the other.

838,006. AUTOMATIC-EXCHANGE CIRCUIT. Albert M. Bullard, New York, N. Y., assignor to Western Electric Company, Chicago, Ill. Filed March 10, 1906. A method of combining manual and automatic exchanges.

838,017. FORMER FOR ARMATURE COILS. William H. Foot, Wilkinsburg, Pa., assignor to Westinghouse Electric and Manufacturing Company. Filed May 8, 1905. An adjustable former.

838,021. CONTROLLING MEANS FOR ELECTRIC MOTORS. Fletcher D. Hallock, Wilkinsburg, Pa., assignor to Westinghouse Electric and Manufacturing Company. Filed June 2, 1905. Renewed January 20, 1906. A drum controller working in connection with a contact disc.

838,028. PHANTOM TELEPHONE SYSTEM. Thomas P. Jordan, Dallas, Tex., assignor to E. H. Cary, Dallas, Tex. Filed October 3, 1904. Renewed December 20, 1905. A method of arranging circuits for preventing cross-talk.

838,034. ELECTRICAL MACHINE. Benjamin G. Lamme, Pittsburg, Pa., assignor to Westinghouse Electric and Manufacturing Company. Filed February 21, 1905. The armature and conductors are placed in two series of slots at different depths, the number of conductors in each slot varying inversely as the depth.

838,048. ELECTRIC MOTOR. Samuel L. Nicholson, Pittsburg, Pa., assignor to Westinghouse Electric and Manufacturing Company. Filed September 25, 1905. The armature is of greater length than the field, and is adjustable longitudinally.

838,090. AUTOMATIC SWITCH MECHANISM. Augustus C. Durdin, Jr., Chicago, Ill., assignor to Erwin & Company, Chicago, Ill. Filed January 13, 1906. A quick-break switch operated by fluid pressure.

838,115. TELEPHONE METER. Newman H. Holland, Brookline, Mass., assignor of one-half to Charles Bate, Quincy, Mass. Filed January 31, 1902. A meter arranged to prevent the use of the transmitter except when released at the exchange.

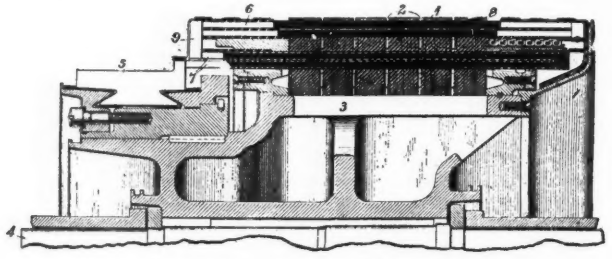
838,117. TELEPHONE SIGNAL. Thomas P. Jordan, Dallas, Tex., assignor of two-thirds to George A. Carden, Dallas, Tex. Filed June 15, 1906. A resetting drop.

838,133. SINGLE-PUSH-BUTTON AUTOMATICALLY CONTROLLED ELECTRIC-ELEVATOR SYSTEM. Frederick W. Newell, Hastings-upon-Hudson, N. Y., assignor to Otis Elevator Company, Jersey City, N. J. Filed June 19, 1905. The speed of the car is automatically controlled by the load.

838,136. COMBINED TELEPHONE AND DISTRICT MESSENGER SYSTEM. James G. Nolen, Chicago, Ill., assignor of one-half to Frank B. Cook, Chicago, Ill. Filed November 26, 1902. A method of attaching a messenger call system to a telephone circuit.

838,138. AUTOMATIC APPARATUS FOR PREVENTING COLLISION OF RAILWAY TRAINS. Maurice Privat, Angoulême, France. Filed January 23, 1904. An electrically controlled, automatic brake-setting system.

838,139. TELAUTOGRAPH APPARATUS. Foster Ritchie, Acton Hill, London, England. Filed March 12, 1904. A pen-lifting mechanism.



838,034.—ELECTRICAL MACHINE.

838,144. DYNAMOELECTRIC MACHINE. William Stanley, Great Barrington, Mass. Filed May 22, 1905. The rotor and stator windings are connected together, external means being provided for impressing alternating electromotive forces upon them.

838,163. HIGH-TENSION INSULATOR. Frank G. Baum, San Francisco, Cal. Filed October 24, 1905. A main section of insulator, furnished with petticoats, supports a supplemental insulator having vertical ridges which allow them to be washed by rains.

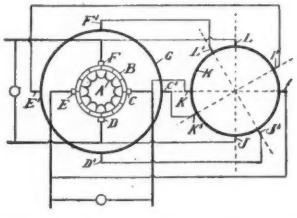
838,165. BATTERY CELL. John W. Brown, Cleveland, Ohio, assignor to National Carbon Company, Cleveland, Ohio, a corporation of New Jersey. Filed June 4, 1906. One electrode is separated from the cell by a non-porous partition which is removed when the cell is put to use.

838,171. ELECTRIC-SWITCH BASE. Nathan W. Crandall, Hartford, Ct., assignor to the Perkins Corporation, Hartford, Ct., a corporation of Connecticut. Filed February 27, 1906. A locking plate is secured to the front face of the base.

838,175. CONTROLLER FOR THE TROLLEY POLES OF ELECTRIC CARS. Alfred J. Edwards, Auckland, New Zealand. Filed August 22, 1906. The pole is held in position by a weight.

838,177. ELECTRICAL CONTACT SHOE. Thomas Fildes, Richmond Hill, N. Y., assignor to George Cook, Allendale, N. J. Filed February 20, 1906. A shoe with inclined edges.

838,192. TELEGRAPHIC RELAY. Isidor Kitsee, Philadelphia, Pa., assignor of one-half to William J. Latta, Philadelphia, Pa. Filed February 26, 1906. A siphon recorder.



838 144.—DYNAMOELECTRIC MACHINE.

838,235. ELECTRIC FUSE. Leonard B. Buchanan, Woburn, Mass. Filed April 2, 1906. An enclosed fuse surrounded by amorphous silicic oxide.

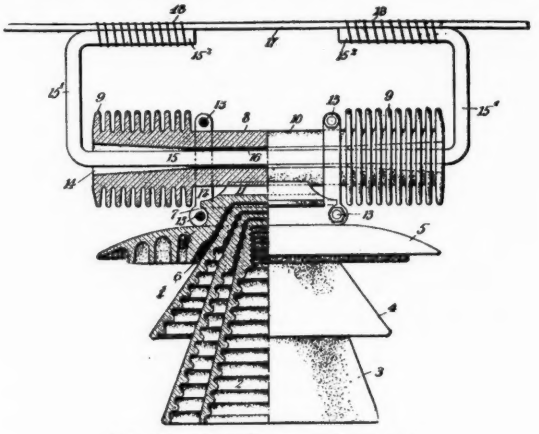
838,244. AUTOMATIC RINGING DEVICE FOR TELEPHONE-EXCHANGE SYSTEMS. William W. Dean, Elyria, Ohio, assignor to the Dean Electric Company, Elyria, Ohio. Filed January 16, 1906. A high-resistance ringer, connected in parallel with a low-resistance telephone, is automatically cut out by a thermal device at the exchange.

838,251. SPARK-COIL BOX FOR MOTOR-VEHICLES. Russell Huff, Detroit, Mich., assignor to Packard Motor Car Company, Detroit, Mich. Filed September 27, 1906. A method of mounting a spark-coil.

838,273. ELECTRIC-WAVE-FORM TRACER. Robert Rankin, Ithaca, N. Y. Filed August 23, 1905. A modified cathode-ray curve tracer.

838,280. MERCURY-VAPOR LAMP. Hans V. Siim-Jensen, Copenhagen, Denmark. Filed April 25, 1905. Renewed November 14, 1906. An auxiliary receptacle, attached to the lamp tube, contains mercury and is perforated at the surface of the mercury in the tube.

838,304. LIGHTNING ARRESTER. Frank B. Cook, Chicago, Ill. Filed May 9, 1906. A thin dielectric of softenable material is interposed between suitable electrodes.



838 163.—HIGH-TENSION INSULATOR

838,315. CONTROL OF ELECTRIC MOTORS. William Geipel and Frederick M. T. Lange, Southwark, England. Filed January 15, 1906. A controlling rheostat which permits a considerable portion of the resistance to be cut out when starting.

838,362. RECEIVER FOR TELEPHONES. Louis Steinberger, New York, N. Y. Filed January 16, 1905. The insulating material of the receiver has a comparatively massive end.

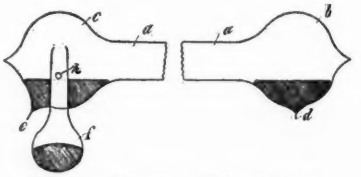
838,372. GALVANIC BATTERY. Benjamin J. Blameuser, Chicago, Ill., assignor to Chicago Compound Battery Company, Chicago, Ill. Filed June 7, 1905. A container for the electrolyte is placed in the bottom of the cell.

838,393. GOVERNING DEVICE FOR DYNAMOS. Charles A. Eck, Newark, N. J. Original application filed August 12, 1903. Divided and this application filed June 15, 1905. Renewed May 29, 1906. A dynamo with longitudinally adjustable armature, the motion of which when attracted by the field-magnets tends to disengage the driving mechanism.

838,404. RELAY. Max R. Hanna, Schenectady, N. Y., assignor to General Electric Company. Filed May 26, 1906. An alternating-current relay for railway-signaling systems.

838,407. SAFETY DEVICE FOR BOOSTERS. John D. Hilliard, Jr., Glens Falls, N. Y., assignor to General Electric Company. Filed July 2, 1904. A reverse-current circuit-breaker for boosters.

838,410. ELECTRIC MEASURING INSTRUMENT. Otto Holz, Schenectady, N. Y., assignor to General Electric Company. Filed July 14, 1905. A frequency indicator actuated by interrupted current.



838,280.—MERCURY-VAPOR LAMP.

838,423. METHOD OF PRODUCING ELECTRIC COILS. Isidor Kitsee, Philadelphia, Pa. Original application filed May 3, 1905. Divided and this application filed June 15, 1906. Conducting material spread upon a non-conducting surface is divided spirally to form a continuous conductor.

838,482. INSULATOR FOR LINE CONDUCTORS. James M. Weed, Denver, Colo. Filed August 10, 1905. The insulator proper is supported on a tubular pin and holds a wire-supporting pin.

838,495. BLOCK-SIGNAL APPARATUS. Alexander Bevan, Providence, R. I. Original application filed February 10, 1906. Divided and this application filed October 25, 1906. An electromagnetically operated target signal.

838,500. WIRE-CABLE CLAMP. John H. Cook, New York, N. Y., assignor to Henry B. Newhall, Plainfield, N. J. Filed October 21, 1901. The clamping bolts are attached permanently to one jaw.